JPRS-CEN-87-005 034096
4 NOVEMBER 1987

FOREIGN
BROADCAST
INFORMATION
SERVICE

JPRS Report

Science & Technology

China: Energy

19990210 066

10
54
Aϕ4

JPRS-CEN-87-005
4 NOVEMBER 1987

SCIENCE & TECHNOLOGY

CHINA: ENERGY

CONTENTS

/12223

BIDDING OPENED ON 500KV XUZHOU-SHANGHAI POWER LINE

OW181436 Beijing XINHUA in English 1331 GMT 18 Aug 87

[Text] Beijing, 18 Aug (XINHUA)--The international tendering company of the China National Technological Import Corporation opened the fourth round of bidding for construction of a second power project in China.

Today, representatives from 42 companies in 15 countries, including Britain, Japan, and the United States, attended the bidding ceremony for the World Bank-funded construction project.

An official in charge of the event said, the project, supported by a World Bank loan of 117 million U.S. dollars, plans to run a 600-kilometer, 500,000-volt high-tension transmission line between Xuzhou and Shanghai.

This round of bids is aimed at purchasing trasnformers and other electrical equipment worth 22 million U.S. dollars, the official explained, adding the first three bidding sessions in 1984 and 1985 were mainly for equipment imports.

Evaluation of the bids will begin soon, and contracts are expected to be granted after evaluation by world bank experts, an official of the international tendering company reported.

Construction of the Shanghai-Xuzhou power line, which was started in 1985, is scheduled for completion by 1990, and will alleviate Shanghai's power shortage when the Xuzhou plant starts transmission.

/12624
CSO: 4010/67

POTENTIAL FOR HYDROPOWER DEVELOPMENT IN SOUTHWEST OUTLINED

HK100321 Beijing ZUNYAN in Chinese No 6, 7 Jun 87 pp 18-19, 20, 21

[Article by Zheng Ping (6774 1627): "The Strategic Position and Role of Hydroelectric Development in the Southwest"]

[Excerpts] China's water power resources rank first in the world, and most of them are concentrated in the southwest. The exploitable water power resources in the southwestern region account for 67.8 percent of the country's total. We can install hydroelectric generators in Sichuan, Yunnan, and Guizhou with a capacity of 175.75 million kilowatts and an annual generated energy of 975 billion kilowatt-hours, accounting for over 50 percent of the country's total. A correct understanding and vigorous development of hydroelectric power in southwestern China is of great significance to China's strategic distribution of energy and its economic development.

1. Its Position in the Nation's Strategic Distribution of Energy

China is not rich in energy resources. In the north there is much coal but little water; in the south there is much water but little coal; and in the east there is an energy shortage. Therefore, "transporting coal from north to south" (including the east) and "transmitting electricity to the east" will be the basic pattern of China's energy strategy. The rich water power resources in the southwest can supplement the uneven distribution of China's coal resources.

"Transmitting electricity to the east" means exploiting water power in the southwest and trasmitting the electricity to the eastern region. In Sichuan, Yunnan, and Guizhou there are a number of rivers rich in water power, such as the upper reaches of the Chang Jiang and the Jinsha Jiang, Yalong Jiang, Dadu He, Wu Jiang, Nanpan Jiang, and Lancang Jiang. Being close to one another, these rivers, plus the nearby Min Jiang, Jialing Jiang, Bailong Jiang, and Chishui He, form an "enriched" hydroelectric cluster in the southwest, with Sichuan as its center, which is about 1,000 km long and 700 km wide. We can install generators with a total capacity of over 100 million kilowatts in this cluster and turn it into an unrivaled, enormous hydroelectric base. Transmitting electricity to eastern, southern, and northern China over a distance of about 2,000 km

comes within the rational scope of power transmission in the contemporary world. Therefore, the water power in southwestern China can share the strategic burden of balancing the nation's energy resources and yield enormous results in various ways, such as improving China's energy structure, protecting and extending the use of mining resources, reducing the pressure on energy transportation, and improving the ecological environment.

We should also note that our country is poor in water resources, that there is a growing shortage of water for industrial and agricultural use and people's daily use, and that the southwest is a region with high water sources and the richest water resources. While exploiting water power in the southwest, we shall also retain and protect water resources. This will play an important role in improving the balance of water resources in the country and in diverting water from the south to the north in the future.

2. Its Role in the Construction of China's Strategic Rear Area

The southwestern region is a treasure house of natural resources. It is especially noted for the three major resources of water power, mineral resources, and forests. Here we have excellent weather conditions for agriculture and plentiful human and material resources. We already have iron and steel, nonferrous metal, petrochemical, national defense, transport, and power industries and fairly strong scientific and technical forces. It is therefore a region with enormous potential for development.

The region is rich in mineral resources. The Panzhihua coulsonite mine, Lanping lead zinc mine, Gejiu tin mine, and Dongchuan copper mine are well known at home and abroad. Moreover, Guizhou is rich in coal and Sichuan has abundant natural gas. The region has over 100 proven mineral resources. Of these, the reserves of titanium and lead zinc rank first in the world, those of vanadium, cadmium, cobalt, phosphorus, and sylvite rank first in China, and those of iron, copper, tin, aluminum, tungsten, manganese, nickel-platinum-antimony, bismuth, and kongsbergite are in the front ranks in China. There are also gold, uranium, and other rare metals, as well as other precious metal resources.

This enormous treasure house is situated in China's strategic rear area. By exploiting water power in the southwest we can obtain enormous, reliable energy not restricted by other regions and thus promote the all-round development of this treasure house and turn its superiority in natural resources into powerful economic superiority. In particular, since the enormous water power resources and the rich mineral resources are situated in the same region, it is convenient to bring into play the superiority of the hydroelectric-metallurgical combination. Hydroelectricity provides the motive force for the exploitation, smelting, and processing of mineral resources and speeds up their exploitation; the export of these raw metal materials and their products to other parts of the country and to foreign

countries as hydroelectricity-carrying agents can also stimulate the development of the hydroelectric power industry. We should take hydroelectric power and metallurgical industries as the key to bringing along the all-round development of the economy in this region and gradually turn the southwest into a modern base with hdroelectric power, iron and steel, nonferrous metal, machine-building, petrochemical, and national defense industries as the main body, a base in which agriculture and light and heavy industries develop in a coordinated way and the ecological environment is balanced, and a major strategic rear area which can support the whole country in peacetime and can survive independently and have inexhaustible potential in wartime.

3. Its Role in the Economic Development of the Chang Jiang Basin

With the population and cultivated land of the Chang Jiang basin accounting for one-third of the national total and its total industrial and agricultural output value accounting for two-fifths of the national total, developing the economy of the Chang Jiang basin is of decisive importance to the nation. The southwestern region is situated on the upper reaches of the Chang Jiang. By exploiting the water power we can not only supply enormous energy but also develop water transport and attain other comprehensive results. This is of great importance to the economic development of the Chang Jiang basin.

The Chang Jiang is China's biggest inland river shipping system but its channel is in a natural or seminatural state. Many sections in the upper reaches of the main stream have many shoals and rapids, the channel is both narrow and meandering, the water is shallow, and the silt deposits obstruct navigation. The Jinsha Jiang section is not navigable. To exploit water power in the southwest, it is necessary to build dikes and reservoirs on the main stream and tributaries on the upper reaches to regulate the runoff and block the silt. In this way we can increase the flow of water in the dry season, increase the depth of channels, reduce silt deposits, and improve existing channels and raise their transport capacities. We can also turn the main stream and some tributaries on the upper reaches into canals, improve shipping, open new shipping routes, and expand the shipping network on the main stream and tributaries of the Chang Jiang. Therefore, the exploitation of water power in the southwest can greatly develop China's main transport artery, which traverses the southeast, links southwestern, central, and eastern China, and stretches as far as the Dong Hai. At the same time, it will also bring benefits to vast areas in the middle and lower reaches of the Chang Jiang in various ways, such as flood prevention, irrigation, aquatic products, water supply, environmental protection, and tourism.

In particular, the exploitation of water power in the southwest and the development of shipping on the Chang Jiang will stimulate the integration of the energy and natural resources on the upper reaches with the technological and economic advantages on the lower reaches and speed up

the overall development of the economy in the basin. In areas along the river where there is plenty of electricity, convenient water transport, abundant products, and a galaxy of talent, a number of new industrial and economic zones will spring up, develop into the Chang Jiang basin economic zone -- the biggest and most prosperous in China -- and become the nation's economic center.

4. Its Role in Stimulating the Construction of the Three Gorges Project

The key Three Gorges water control project can yield enormous results. Many major problems related to this project are being expounded and proved and some of them cannot be solved by the Three Gorges project itself. The exploitation of water-power on the main stream of the upper reaches of the Chang Jiang and its tributaries will create favorable conditions for the construction of the Three Gorges project at an early date.

During the kind of flood occurring once every 100 years, the flow of flood water at the Three Gorges over 30 days can total 138.6 billion cubic meters, accounting for 55-76 percent of the water flow in Hankou. Controlling the flood at the Three Gorges can play a big role in preventing flooding in the middle and lower reaches of the Chang Jiang. But the plan for building 150-180 meter dikes at the Three Gorges will not play a significant role in controlling floods because the flood prevention reservoir can only hold 7.3-19.6 billion cubic meters of water. The storm centers that cause floods at the Three Gorges are in western and northwestern Sichuan rather than in eastern Sichuan, which is close to the Three Gorges. The key to controlling flood water at the Three Gorges lies in building reservoirs to retain the flood on the Jinsha Jiang, Min Jiang, Jialing Jiang, Wu Jiang, and other tributaries.

The annual volume of sand transported by the Chang Jiang has increased from 0.52 billion tons to 0.68 billion tons. This will cause serious silting at the Three Gorges reservoir. According to the 150-meter-dike plan, the silt in the waterway at one end of the reservoir will obstruct shipping. According to the 180-meter-dike plan, the silt at one end of the reservoir will silt up the mouth of the Jialing Jiang and turn Chongqing, the biggest inland port in the southwest, into a dead port. As for the source of silt at the Three Gorges, the Jinsha Jiang (plus the Yalong Jiang) accounts for 48 percent, the Jialing Jiang 32 percent, and the Min Jiang, Dadu He, Tuo Jiang, Wu Jiang, Chishui He, and other tributaries 17 percent. Therefore, to solve the problem of silt deposits at the Three Gorges, in addition to stepping up water and soil conservation, we should also build dams to retain sand in such tributaries as the Jinsha Jiang, Jialing Jiang, Min Jiang, and Wu Jiang.

The Three Gorges power station would have a very poor self-adjusting capacity. During the dry season, its electricity production would amount to only a quarter of that during the rainy season. The poor quality of power supply would make it necessary to build other power stations with an installed capacity of 10 million kilowatts to make up for the loss.

By exploiting water power in the southwest we can make up for or adjust the water supply to the Three Gorges through reservoirs built on the main stream and on tributaries in the upper reaches of the Chang Jiang, increasing the flow of water to the Three Gorges power station during the dry season to increase its capacity to generate electricity and to reduce and even assume the burden of other power stations. In this way we can bring into full play the benefit of the Three Gorges power station in generating electricity and, at the same time, reap the benefit of retaining fllods and sand for the Three Gorges reservoir.

5. Excellent Conditions for Exploiting Water Power in the Southwest

Most of the rivers in southwest China flow from the Qinghai-Xizang Plateau, which is known as the "roof of the world," the Hengduan Mountains, and the Yunnan-Guizhou Plateau to such lowlands as the Sichuan Basin. The difference in height is great. Moreover, with heavy rainfall in the region and a water supply from snow-covered mountains and glaciers, the runoff is both rich and stable, which is favorable to electricity production. There are so many high mountains and canyons along the rivers and the rock is so solid that we can build dams in many places. To build such canyon reservoirs, it is unnecessary to inundate vast expanses of land, and they also have little adverse ecological effect. This is the region where proposed sites for building large and extra-large hydroelectric power stations are most concentrated in China and in the world. There are many good sites for building power stations, the exploitation of these sites will yield enormous benefit, and the economic indicators for kinetic energy are excellent. Viewed from some key development areas in the region, we generally have to invest 900-1,000 yuan for each kilowatt of installed capacity, 0.15-0.20 yuan for each kilowatt-hour of generated energy, and 2,000-3,000 yuan for backup facilities for the transmission of each kilowatt of power. To set up generators with an installed capacity of 10,000 kilowatts, we will have to inundate very little land and to move 20-100 people. Such excellent indicators are rare in other regions of our country. We have gained successful experiences in building large and medium-sized hydroelectric power stations at Gongzui, Wujiangdu, and Yilihe. In southwest China and the neighboring regions we have the largest hydroelectric prospecting, design, and building contingent in the country, and a strong capacity for producing hydroelectric power equipment. Once a key region for "third line" construction, southwest China's economy has developed rapidly. With Chongqing, Chengdu, Kunming, Guiyang, Dukou, Zigong, and other cities as the center, it is developing into an economic zone with unique characteristics. In view of its great demand for energy, its urgent need to exploit water power, its rich human and material resources and scientific and technological forces supporting hydroelectric power construction, and its ability to meet, within the region, the need for building materials such as steel products, wood, and cement, the subjective and objective conditions for exploiting water power in this region are very good.

In terms of benefits to the Three Gorges project, if we build 25 large and medium-sized hydroelectric power stations at Ertan and Jinping, along the Yalong Jiang; at Xiluodu and Baihetan, along the Jinsha Jiang; at Zipingpu, Futangba, Zhouba, and Bingling, along the Min Jiang; at Pubugou, Gongzuijiagao, Zhile, and Dusong, along the Dadu He; at Baozhusi; Tingzikou, Miaojiaba, Zhangtan, Fengxiangtan, and Fengtan, along the Jialing Jiang; at Hongjiadu, Dongfeng, Goupitan, Silin, and Pengshui, along the Wu Jiang; and at Lintan and Mozitang, along the Chishui He, we will have reservoirs with a total storage capacity of over 50 billion cubic meters, and the capacity of these reservoirs to control flooding will be 100 percent more than the 150-meter-dike plan for the Three Gorges. As regards shipping, we can open up a route in the Jinsha Jiang, so that we can sail directly from Dukou City to the Dong Hai, thus extending the route by one-third. We can also improve the existing routes on the Jialing Jiang, Wu Jiang, Chishui He, Dadu He, Yalong Jiang, and other tributaries, and open up new ones. With regard to electricity, in addition to installed capacity of over 44 million kilowatts, as well as the benefit brought to the power stations on these rivers, they can also enhance the capacity of the two power stations in the Three Gorges and at Gezhouba by 2.5-3 million kilowatts.

/12624
CSO: 4013/89

GEZHOUBA POWER STATION SAID TO WASTE WATER, ELECTRICITY

HK040333 Beijing RENMIN RIBAO in Chinese 30 Jul 87 p 2

[Dispatch by Reporter Wang Chu (3769 2806): "Gezhouba Power Station Loses Appalling Volumes of Water and Power"]

[Text] Wuhan, 29 Jul--"This year, the Gezhouba Power Station will be unable to use a volume of water that would enable it to generate 700 million kWh of electricity, and will be unable to use another volume of water that would enable it to generate 1.35 billion kWh of electricity next year. This means that the equivalent to 810,000 tons of raw coal will be wasted." This is what Comrade Huang Fang [7806 2455], responsible person from the Central China Power Supply Network, remorsefully told this reporter in an interview not long ago.

The Gezhouba Power Station is the country's largest run-off station. However, it is incapable of self-regulation. The amount of electricity it generates is directly proportional to its water intake and cannot exceed what its designed capacity permits. However, neither the water from the Chang Jiang nor the electricity can be stored. Each year, during the high-flow season, the station has difficulty transmitting the electricity it generates, with the result that much electricity has to be wasted." To ensure the safety of the power supply network and the generators, the plant has to shut down the generators.

According to a comprehensive data analysis on the production and consumption of electricity in Hubei, Hunan, Henan, and Jiangxi, we can effectively prevent the Gezhouba Power from resorting to the practice of suspending operation by applying economic levers and pricing mechanisms.

At present, whether generating electricity in the high-flow or low-flow season, the Gezhouba Power Station always keeps the price of electricity up and never lowers it. What is even more unreasonable is that the price of the electricity it generates is more than double that generated by other hydroelectric staitons and thermal power plants. The small hydroelectric power stations in Hubei, Hunan, Henan, and Jiangxi, which are incorporated into the Central China Power Grid, have a combined capacity of more than 1 million kW. During Chang Jiang's high-water season, the Gezhouba Power Station and the small hydroelectric power stations in the

four provinces can produce much electricity. This year, the Chang Jiang's high-water season and Jiangxi Province's began almost simultaneously and various provinces would rather use locally generated thermal and hydroelectric power, which is cheaper, than purchase power from Gezhouba. Thus, it is necessary for Gezhouba to maintain floating prices for peak and valley periods.

What should be pointed out is that on the one hand, there is the Gezhouba Power Station which always has a "surplus" of electricity, and, on the other, there are mines and enterprises which are "starved" for electricity. As far as this reporter knows, power consumption in Hubei, Hunan, Henan, and Jiangxi is governed by fixed annual consumption quotas. If a mine or an enterprise consumes more electricity than it is allowed during the high-water season, it will have little to consume in winter because it has consumed too much in advance. Yichang City is not far away from Gezhouba. In addition, it has its own power plants. However, its industries do not have adequate power supplies because after weighing the pros and cons, the city has decided not to use more electricity than it is allowed. Some experts have repeatedly argued that during the peak supply periods, when Gezhouba takes full advantage of the high-flow to generate more electricity than in normal times, the mines and enterprises should be allowed to use electricity more freely or, at least, without having to face the problem of subsequent reduced consumption quotas. However, if an enterprise does not consume as much as it is entitled to during peak supply periods, it will not be given an additional supply later. The purpose of this is to encourage the enterprises to consume more during the peak supply periods and to prevent the power plant from abandoning too much water.

An important way to reduce the amount of electricity wasted at Gezhouba is to quicken the pace of the construction of complementary facilities, such as transmission networks and transformer stations. The electricity generated by Gezhouba is mainly supplied to eastern Hubei, central Hunan, and central Henan. However, because of the inadequate number of step-up transformer stations along the transmission and transformer lines, central Hunan and central Henan cannot take in too much electricity. As for the transmission lines between the power station and eastern Hubei, they are still only on paper because the relevant departments are bickering among themselves. Huang Fang said: "The lack of complementary facilities adversely affects the transmission of electricity from the Gezhouba Power Plant. Once the Dajiang facility goes into operation, this problem will become even more serious."

/12624
CSO: 4013/89

RURAL HYDROPOWER PROJECTS NOW BOOMING

OW110637 Beijing XINHUA in English 0618 GMT 11 Aug 87

[Text] Beijing, 11 Aug (XINHUA)--China, in an effort to develop hydraulic power stations in rural areas, has now built more than 67,000 such stations across the land.

According to statistics from the Ministry of Water Resources and Electric Power, the installed capacity of these stations is 10.06 million kW, making up one-seventh of the national total. These stations provide electricity to 33 percent of the counties and 42 percent of the agricultural production units in China.

In the 1950s, when China began to develop hydraulic power stations in rural areas, state investment was the only financial source and the number of the stations increased slowly. With the reform in China's countryside since 1979, various fund-raising channels have appeared to meet the growing demand for electricity in the countryside, and this has spurred greatly the development of power stations.

Statistics show that 92 percent of the stations are run by towns and villages. Their installed capacity makes up 40 percent of the total in the rural areas.

Since 1985, on the basis of state loans totalling 100 million yuan, electrification experiments have been made in 100 counties through various fund-raising channels to promote the development of hydraulic power in the countryside.

The total installed capacity of these counties has now reached 1.85 million kW, 60 percent of the target for 1990, when these counties are expected to be completely electrified.

Hydraulic power stations with a total installed capacity of 620,000 kW were put into operation in the rural areas in 1986. These and previous ones provide electricity to one-third of the counties and 40 percent of the small towns in China.

/12624
CSO: 4010/67

BRIEFS

GROUND BROKEN ON ERTAN--Early this month [September] construction was officially begun on the big Ertan hydroelectric power station in Sichuan, a project recently approved for inclusion in the Seventh 5-Year Plan by the State Council. The ertan hydropower station is located on the Yalong Jiang near the city of Panzhihua. Multiple cascade power stations can be built on the Yalong Jiang--whose banks are precipitous and drop large--which has abundant hydropower resources. The Ertan hydropower station is the first to be built as part of the Yalong Jiang [development] plan and will have an installed capacity of 3 million kilowatts that will generate some 16.2 billion kilowatt-hours of electricity a year. It is larger than Gezhouba and will generate two-thirds of all the electricity now being generated in Sichuan Province. [Text] [40130002a Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 12 Sep 87 p 1] /9274

SHAXIKOU GOES ON STREAM--At 1710 hours on 9 September, the Shaxikou hydroelectric power station, a major state construction project, went on stream without a hitch. The Min Jiang Construction Bureau of the Ministry of Water Resources and Electric Power built this large-scale hydropower station. The station has an installed capacity of 300,000 kilowatts and was completed 2 years ahead of schedule. [Summary] [40130002b Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 12 Sep 87 p 1] /9274

ADVANTAGES OF DEVELOPING 600-MW SUPERCRITICAL POWER PLANTS OUTLINED

Shanghai DONGLI GONGCHENG [POWER ENGINEERING] in Chinese, No 3, 15 Jun 87, pp 1-7

[Article by Zhao Zhiyi [6392 0037 0001] Deputy Chief Engineer, Shanghai Municipal Economic Committee: "Developing Supercritical Fossil Power Plants to Promote Power Plant Construction and Manufacture of Generating Equipment"]

[Abstract: This article discusses the reliability and economy of supercritical pressure thermal power plants and the feasibility of developing such plants in China. Based on this, goals, policies, and methods are proposed for developing in China coal burning variable pressure supercritical units with the expectation of putting two supercritical 600-megawatt fossil fuel units in operation in 1990 at the Shanghai Shidongkou Power Plant No. 2.]

[Excerpts] I. Introduction

The development of the technology for generation of electricity from fossil fuels exhibits one fundamental principle: Each major technology advance has always proceeded from breakthroughs obtained in increasing unit thermal efficiency followed by further increases in advancing other technical and economic standards. In the last 10 years, single-unit thermal power generators stabilized at about 600 to 800 megawatts. Increasing the steam parameters to develop supercritical pressure units has become the major avenue for increasing thermal efficiency.

In 1986, the State Planning Commission and Shanghai Municipality decided to order from abroad two 600-megawatt supercritical pressure coal-burning variable pressure units and install them at the Shanghai Shidongkou Power Plant No. 2. At the same time, under the condition of reducing costs, the necessary design and manufacturing technology related to the supercritical process was imported and that hardware that could be produced domestically was requested, striving to make units 3 and 4 of the Shidongkou Power Plant be independently developed and produced supercritical 600-megawatt units. This is one strategic policy of national major construction tasks providing powerful insurance that China's electricity generating equipment industry will rapidly attain the standards of the 80's and that by the end of this century, the national standard of coal consumption for power generation will fall from 440g/kilowatt-hour to 355g/kilowatt-hour.

II. The Feasibility of Developing Supercritical Units in China

Since super critical units have higher technical and economic standards, these units are commonly used in Europe, the United States, Japan, and the Soviet Union. Of these, the United States was the earliest to develop supercritical units while Japan and the Soviet Union, have continually made development of supercritical units serve as an important link in their energy resource industrial policies.

1. Reliability of Supercritical Units

The use rate of the early supercritical units in the United States was only 64% to 69%. However, the latest accounts indicate that America's 800-megawatt supercritical units have an average use rate of 90%, higher than that for other parameter units with the same capacity grade. In addition, according to the projections of the north american power reliability council, in 1990 the shut-down rate of American coal-fired supercritical boilers will have fallen 1% from the rate for the beginning of the 1980's. This indicates that the reliability of supercritical units will continually increase.

2. Economy of Supercritical Units

If we compare widely used subcritical units (169ata, 538/538°C and supercritical units (240ata, 538/538°C), the cost of the suprcritical units is higher by 1 to 3.8% but the heat dissipation is 2 to 4% lower. After considering the various factors of unit efficiency, coal cost, steel products, and equipment expenses, the general conclusion is that developing supercritical units is suited to regions with high coal costs while those with low coal costs can develop subcritical units. Consequently, to develop supercritical units on the coal-poor coast of China is appropriate and beneficial while in regions with rich coal resources such as Shanxi, it is better to develop subcritical units.

Picking the best bids, the boiler efficiency, plant power consumption, etc. are about the same for sub and supercritical units but the turbine heat dissipation differential is rather large. The heat dissipation of a 600-megawatt supercritical unit turbine is 80 to 90 kilocalaries/kiolowatt-hour lower than for the turbine in a subcritical unit with the same capacity. Computing according to international practice, for a 600-megawatt unit, the effect of this sort of heat dissipation differential on the unit's cost will be over 20 million U.S. dollars. Generally speaking, the equipment expenditure for a supercritical power plant boiler island and turbine island is 5 to 10% higher than for a subcritical unit. (In the fierce competition of international markets, the costs are nearly the same.) However, since the cost of this particular equipment is only about 20% of the cost of the entire power plant construction, the effect of using the parameters of a supercritical unit on the total cost of the power plant is only about 2%. For a 600-megawatt unit, it only increases the cost by a few million U.S. dollars. This is only a minute cost compared to savings obtained in the operation of a supercritical unit.

3. The Feasibility of Developing Supercritical Units in China

Due to the impact of the "Cultural Revolution" on Chinese-built fossil units, in the transition years between the 70's and the 80's, accidents were frequent. Also, the subcritical units we have built based on the technology of Westinghouse and CE [Combustion Engineering] of the United States have, for various reasons, risen in price and have only this year been placed in service, so their actual performance has yet to be verified. For this reason there are some who have various doubts about developing supercritical units in China at the present. There is also another view noting that even a technologically highly developed country like the United States has made several detours in the process of development of supercritical units. Consequently, some feel that development of supercritical units is a task for the future and so in planning do not schedule the production of the first supercritical unit until the year 2000. This sort of caution is understandable. However, if we closely examine the course of development of our national power plant equipment manufacturing industry in the last 10 years, we discover that while there is a historical reason for this sort of doubt, it is rather negative and has insufficient basis.

Diligently summarizing the last 10 years' experience in key tasks of power plant equipment perfection, the 300-megawatt and 600-megawatt units imported and built, and the more complete technology mastered, we already have the capability to initiate, design, and produce 600-megawatt subcritical units. The quality and reliability of domestically produced units has also attained fairly high standards. Of the large-scale fossil units with a total national production capacity in 1986 of 5,000 megawatts, the three units with the best use rate and load rate were all domestically manufactured equipment. The Chinese-made Shandong Zuoxian County Power Plant's 1,000 metric ton/hour subcritical boiler, which operated successfully the first time, is a prominent example of the level of performance of Chinese large-scale fossil equipment manufacture.

The parameter grade of the supercritical unit we intend to develop is 240ata, 540/560°C. This temperature is the same as that for a subcritical unit, only the pressure parameter is increased. Consequently, the major degree of technical difficulty is confined to the supercritical confinement portion.

From a main machinery analysis, we have the following conditions:

(1) We are already capable of designing and producing subcritical units. It is estimated that this constitutes 85 to 90% of supercritical design technology and in the technical area it constitutes over 95%;

(2) Making use of introduced technology and imported units;

(3) Obtaining even more recent technological information from the international community through various channels;

(4) Complete application of technology already acquired;

(5) The necessary software can be introduced into our own production.

It should be noted that all the necessary conditions now exist.

The supercritical unit developed should be adaptable to various kinds of coal and have better peak regulation and load variation performance. Consequently, we should develop a supercritical, coal-burning, variable pressure operation unit. The structure of the boiler ought to be a spiral tubular loop Bunsen type direct flow boiler. This sort of boiler is capable of adapting to varying pressure operation and can give the unit even greater operating economy. When operating at nonfull loads, as compared to a fixed pressure unit, the efficiency of a variable pressure unit is higher by about 2%. The goal of China in large technical apparatus is always to domesticate production and lower construction costs so as to ensure technological advance and drastically save on foreign exchange.

At present, expansion of electric power is a deciding factor in the development of the entire economy and the critical lack of electric power has already become a major cause for economic difficulties nationally and in every region of China. The Party Central Committee has been explicit in the important measure of "collecting capital to manage electricity and managing it on several fronts" and in an all-out effort to promote power generation in "compressed air". This provided a decisive act to overcome the electricity supply shortage. However, it should be noted that a deviation in electricity development which has emerged several times in the past has also reappeared: a profusion of defects in several hundred industrial boilers ordered by power plants of several thousand to several hundred thousand kilowatts; the blind importing of general, even backward, products from abroad in the planning of power plants leading to repeated imports, wasting large quantities of foreign exchange; and ignoring mature advanced experience both foreign and domestic. However, we must make great strides in the main stream and strategic areas of the electricity campaign in order to contribute to the saving of energy resources in the great development of electric power. We believe that introducing and developing supercritical units must provide the best technological and the optimum economic gains. At present, we must diligently analyze and research the technological conditions of domestic and foreign power development, proposing goals, policies, and methods for the struggle.

(1) Clearly, China's coastal regions should develop coal-burning, variable pressure, supercritical generating units. From a comparison of previous efficiencies and costs for supercritical units, the ratio of cost increase to efficiency increase is the same. Table 4 provides rough computations from heat dissipation and partial data.

Table 4

	heat dissipation coal consumption (kilocalaries/kWh)	generated electricity coal consumption (grams/kWh)	provided electricity coal consumption (grams/kWh)
domestic imported units	1917	317	332
imported produced 600MW units	1912	316*	331*
supercritical units	1920 to 1930	302*	316*

*estimated data

Although theoretical the above figures will not be too far off. Therefore whether or not the 600-megawatt unit is selected will each year effect 100,000 metric tons of coal consumption. Hereafter, regardless of whether it is a domestically produced or an imported unit, it should be a coal-burning variable pressure supercritical unit.

(2) Definite technical advances and type units with foreign mature experience serve as the objective of the struggle in which wrong turns must be minimized and the first battle be a victory. When the United States developed supercritical units in the 50's and 60's, the parameters were too high, leading to many detours. The Soviet Union and Japan used 540 to 560°C as a basis and developed steadily with a more even course, becoming the world's lowest average coal consumers.

In our imports, we adopted the mature foreign 240ata/540°C/556°C units for which reliability is more assured. At the same time, the supercritical technology which accompanied the imported units is a necessary condition for successfully manufacturing of supercritical units domestically.

Based on foreign experience, mastering unit variable pressure operating technology to satisfy the peak regulation requirements of a large network is a central link in our total technological aims.

(3) Selecting the best bids will introduce advanced yet reliable technology. The Huaneng General Company and Shanghai Municipality cooperate closely along paths of reform and in negotiations with foreigners on importing equipment, proceeding simultaneously in the four areas of technology, commerce, credit, and trade. In the latter half of 1986 this continued, with not only plant construction and operation specialists but also manufacturing specialists being part of the technical negotiations.

There are advantages to having manufacturing unit specialists involved in the aspects of equipment design and the unit's coordination. When they and the operations specialists negotiate together with foreign sellers, the technological quality of foreign equipment is completely evaluated. Also, since we are the buyers, conditions are proposed in talks for free or cheaply imported technology. Also there are some strong companies which are farsighted and themselves technically developed so that most of them, for the sake of long-term benefits, will agree to our considerations, consultations, quality inspections, and subcontractors as well as to providing software programs at an affordable price. This spells low expenditure and high benefits for our large-scale equipment imports.

(4) Entering into foreign information markets. Because China's power needs are pressing we occupy a unique place in world power equipment markets. On the other hand, China has the good quality science and technology capacity to be capable of independently developing power generating plants. Therefore, we have the conditions, using bids and other avenues, to enter into international information markets.

The International Supercritical Unit Conference held in Shanghai in November 1986 was the largest scale international meeting held by the Chinese power plant industry. The meeting generally summarized domestic experience and rather systematically collected the supercritical technology experiences of the world's major companies.

The selection of equipment bids is a major avenue for obtaining information. "Know yourself and know the enemy and you can fight a hundred battles with no danger of defeat." Our negotiating partners are not a single company but rather several companies and groups which are fiercely competing against each other. Each company wants to expand on its own technological superiority and contrast it to another's inferiority. This provides a large quantity of information to use to sort the wheat from the husk, the true from the false. Through negotiations, we can clarify up-to-the-minute causes and directions of development of various similar supercritical fossil units. For example, the development and conditions of straight versus helical boilers; why the slow development from high and mid pressure separate cylinders to combined cylinders in steam turbines; and that certain recently formed innovative companies although surpassing some large-scale companies still have deficient technical depth. All this information provides us with valuable insights.

(5) Complete exploitation of our own inherent technological strengths appropriately married to foreign advanced experience will make it so that in the process of importing equipment we can simultaneously and rapidly develop and manufacture supercritical units having special Chinese characteristics. Present Chinese technology in certain areas has attained international standards. As everyone knows, the quality and efficiency of Chinese inner water cooling, welded rotors, welding technology, machining quality of certain components, and processing, like the film water-cooled wall production line of domestically designed units, have all attained the recognition of domestic and foreign specialists. There are also similar examples in commercial product design. For example, a certain Japanese company, after importing an American

company's jet nozzle technology, improved it so that it is very similar to a Chinese domestically produced unit. In addition, in technical exchanges between a Chinese company and a foreign company we proposed a model which was then used by the foreign company in a new design.

Therefore, by complete exploitation of our own advantages, independent and self-initiated appropriate absorption of foreign advanced technology is an important means for modernization of Chinese generating equipment.

(6) We should diligently absorb the experience inherent in the lessons of foreign technological development and expand development and reserch work. From the bidding process we can see that international technology is advancing rapidly, competition is keen, and many companies have strongly expanding structures.

To develop large-scale power plants we must strive for domestic production and expand development and research on aerodynamics, vibration, materials, combustion, and structural strength. In addition, work instigated by large power plants such as electrical network oscillation, supercritical pressure control technology, and especially system matching interfaces, CAD, and CAM, must be exploited and researched.

An important aspect of developing software is subsystem matching, that is BOP. A power plant is actually composed of 7 to 10 systems which constitute about 50% of the total cost of the plant making them a deciding factor in the level of cost of a plant. Certainly we must learn the system engineering principles universally employed abroad. That is to say, from the point of view of systems operation, we certainly do not require each piece of equipment to have the same level of advancement. Even more, we do not want to abandon the domestic industrial foundation and copy each piece of equipment from abroad. Rather, under the premise of fulfilling total system requirements, we should use our own experience and crystallized national sentiment to develop and produce the units. This will require us to use a self-strengthening spirit to digest imported technology to achieve domestic production. For the portion with non-supercritical parameters it is even more the case that we cannot cast off technology we already have and technology already imported and start all over again. Only by proceeding in this way is there a possibility of greatly reducing costs without lowering technological standards.

(7) Using the development of a supercritical unit as the "spigot", we should combine domestication of imported units with optimization of domestically produced units and carry out unified planning to realize modernization of China's large scale fossil electric units.

Each kilowatt-hour of electricity produced by a supercritical unit consumes about 300g of coal, which is obviously efficient. This will promote increases over the levels of China's subcritical units in the areas of technology and economy. Conversely, deciding on the domestication of imported units (supporting or deepening technological advancement and greatly reducing costs) and the optimization of domestically produced units (fundamentally supporting cost levels and making technological levels approach imported units) will become an important constituent in supercritical unit development.

It should be pointed out that supercritical units are based on a higher level of technology than subcritical units. The differential between the two is the height of the layers while the bulk of the technology is similar. In the area of technical manufacture the two are also basically identical. However, some who are not thermal technicians regard "supercritical" as a dividing line, and view the two as completely different products. This is a technological misunderstanding. For example, even if we conscientiously manufactured a 300 megawatt subcritical unit according to import requirements, its thermal dissipation would still be 1930 kilocalaries/kilowatt-hour and there would be no way to compete in domestic and international markets. The imported technology would have to be continually improved before there was a possibility of reaching the level of the 80's.

Therefore we must first form a plan and establish a strong directing unit. Then we must specify the struggle goals for supercritical and subcritical units and organize the areas which promote both types under one system to form an organic whole. In the process of design and production of a supercritical unit, to produce a superior subcritical unit will take the level of the large power plants in China to a new high point.

With auto control as an example, foreign development has been very rapid from single coordination to modular control all the way to total channel random processing. The control level has increased quickly but the structure remains simple to the point that the price has also fallen. If there was a single transverse agency to establish ties between the various types of automatic control technologies, certainly the effect would cut the work in half while doubling the result.

In sum, we want to import on one side while planning, developing, and producing a domestic supercritical unit on the other. In import negotiations, the negotiation teams on one hand will negotiate while on the other closely following the plan for China herself to design and produce a supercritical unit. The basic plan is this: the subcritical portion uses our own technology while the supercritical portion works to absorb foreign technology and carry out our own research and development. Based on preliminary analyses, under the premise of being ensured technology will reach import levels (low thermal dissipation variable pressure operation), the price of a domestically developed supercritical unit will be vastly lower than the price of imported equipment. It is estimated that the cost of each such kilowatt would be about 110 to 130% of the Shitongkou Power Plant No. 1 domestically produced 300 megawatt unit.

III. Conclusion

1. Coastal region imported or developed supercritical coal burning variable pressure fossil electric units will provide a strong guarantee of a large amplitude reduction of coal consumption for electricity generation after China's eighth five year plan. This would move up by 8 years the original plan to be realized in the year 2000.

2. The Huaneng General Company and Shanghai Municipality used the method of bid selection for the organization of manufacturing sector specialists to

participate in negotiations and to import technology. This is a major step for subsequent large development of the electrical industry and the entry of Chinese power plant equipment into international markets. It also serves as a model for achieving the aim of a technical-trade combination when importing important equipment.

3. The first supercritical 600 megawatt coal burning unit in China will be placed into operation in 1990 at Shitongkou Power Plant No. 2. Simultaneously with its import we should immediately organize a plan for domestic manufacture of a 600-megawatt coal burning supercritical unit. Seeking to place two Chinese made plants in operation at Shitongkou Power Plant No. 2 in 1992 to 1993, it is appropriate at this time to import a 600-megawatt coal burning variable pressure supercritical unit with foreign technology.

12966/12379
CSO: 4013/86

BRIEFS

DAWUKOU UPDATE--Ningxia's largest pit-mouth power plant, the Dawukou power plant, is now under stepped-up construction. This thermal power facility has four 100,000-kilowatt generating sets for a total installed capacity of 400,000 kilowatts; three of these units are already operational. It is estimated that the plant could be completely operational by October 1987. [Excerpts] [40130004 Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 20 Jul 87 p 3] /9274

COAL INDUSTRY MINISTER ON SUPPLY AND DEMAND

OW190744 Beijing XINHUA in English 0727 GMT 19 Aug 87

[Text] Beijing, 19 Aug (XINHUA)--China's coal production can basically meet the demand of the national economy and the coal supply and demand will continue to ease, disclosed Yu Hongen, minister of the coal industry today.

Yu said that Shanghai and Guangdong, Zhejiang, Jiangsu, and Hubei provinces where coal used to be hard to come by could not only buy the coal but choose the coal they wanted. The country's large and medium-sized coal mines were arranged to produce 450 million tons of coal this year but the customers only needed 410 million tons.

The minister made an analysis of the historical changes:

Since the government instituted the reform and open policy, a series of policies and measures conducive to coal production have been adopted. The state and collectives, as well as individuals all joined in the production at different levels.

In 1979, the nation's coal production was 635 million tons and in 1983, the amount was 700 million tons. Some 890 million tons of coal were mined in 1986, a 277 million ton increase over 1978. In the first 7 months of this year, coal production has exceeded 500 million tons so the coal supply will continue to ease.

The market has been invigorated. In the past, the coal was allocated solely by the state. Now, the coal mines enjoy more autonomy and can sell the extra coal produced outside the state plan at floating prices. This helps to solve the supply and demand problem through markets.

Customers can get more coal through cooperation with coal producers in materials, finance, technology, and personnel. In 1986 alone, the state bureau of materials and equipment arranged 18.63 million tons of such cooperation coal.

Meanwhile, the widespread energy-saving drive in China has created conditions to reduce coal demand. According to statistics, China saved an annual average of 20 million tons of standard coal in the 1981-1985 period. The energy saved in 1986 is equivalent to 20 million tons of standard coal and more coal is expected to be saved this year, the minister said.

/12624
CSO: 4010/67

BRIEFS

4-TRILLION-TON RESERVE--China has recently verified its total reserves of coal at 4 trillion tons, putting it into the leading ranks of coal-producing nations. Its yearly coal output now is over 800 million tons, ranking it second in the world. A leading coal expert has stated that 30 percent of the nation's coal is located in Junggar in Xinjiang, and Inner Mongolia and the Northeast, and 64 percent is located in the Tarim and North China regions. [Excerpt] [Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 1 Sep 87 p 1] /12223

CSO: 4013/0009

BRIEFS

JIANGHAN GAS WELL--The daily output of natural gas at the first high-yield gas well discovered in the Jianghan oil field may reach 138,800 cubic meters. The gas well is located in the Tankou region of the Jianghan Plain, about 160 km from Wuhan. The well was discovered when a blowout occurred during drilling operations at Tankou Well No 32 on 30 August. Tests have shown that the well is located at the 620-625 meter level, making it the first high-yield gas well found in China at such a shallow level. [Summary] [40130003a Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 4 Sep 87 p 1] /9274

SHENGLI RESERVES REVISED--Xinhua, Jinan--Following a 6-month effort, the Binhai oil zone of the Shengli oil field has found an additional 100 million tons of petroleum reserves. In March 1987, Shengli assembled more than 40,000 personnel and 70-odd drilling rigs in the Binhai oil zone on the northern banks of the Huanghe estuary--an area covering more than 2,000 square kilometers--to conduct a massive [prospecting] campaign. After 6 months, the workers had overcome complex problems to add additional reserves to the field. [Excerpts] [40130003b Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 13 Sep 87 p 3] /9274

PROSPECTS IN SOUTHERN GUIZHOU--Guiyang, 17 Jul (XINHUA)--A group of Chinese and foreign geologists have discovered for the first time the possibility of oil and gas in the marine carbonatite of southern Guizhou Province after 3 years of prospecting. The geologists revealed their findings at a meeting which closed here yesterday. They said they regarded the discovery as a "great breakthrough." Prospecting for oil and gas in marine carbonatite is considered a "hard nut to crack" worldwide because of its complicated geological structure. China began to cooperate with the United Nations development program and the UN Department of Technical Cooperation for development in this field in 1984. With advanced equipment, a 1,000-kilometer regional seismic profile has been drawn up. China has more than 1 million square kilometers of marine carbonatite, mainly in the south. [Text] [Beijing XINHUA in English 1453 GMT 17 Jul 87] /9604

SINO-FRENCH WELL PUMPING OIL--Guangzhou (CEI)--Another high-yield oil well went into operation in the Guangxi Zhuang Autonomous region recently. The area is being jointly developed by the Nanhai (South China Sea) Western Petroleum Corporation and Total Petroleum Corporation. The well has turned out around 7700 bbl of oil per day since 28 June when extracting began. The Wei 10-3 oil field went into production on 7 August last year. It had turned out 2.1 million bbl of oil by the end of June 1987. [Text] [Beijing XINHUA in English 0629 GMT 5 Aug 87] /9604

ANHUI STRIKE LOOKS PROMISING--Beijing, 30 Jul (XINHUA)--Chinese geologists have obtained an oil flow of industrial value from a well drilled in Dawang village, Anhui Province, the Ministry of Geology and Mineral Resources announced today. This forecasts an optimistic future for prospecting in the area, which covers 100,000 sq km and includes the provinces of Henan, Anhui, and Jiangsu. Drilling in the area began in 1982. [Text] [Beijing XINHUA in English 1453 GMT 30 Jul 87] /9604

SICHUAN GAS OUTPUT--Sichuan's natural gas industry has recovered 92.3 percent of its investment in the past 5 years. The new gas reserves exploited during this period amounted to an increase of 11.7 billion cubic meters compared with the Fifth Five-Year Plan. Natural gas production has risen by 550 million cubic meters over the 1982 figure. [Summary] [Chengdu Sichuan Provincial Service in Mandarin 0000 GMT 13 Aug 87 HK] /12624

NEW XINJIANG WELL--Beijing, 11 Aug (XINHUA)--A test well with a daily capacity of 100,000 cubic meters of gas was drilled in the Xinjiang Uygur Autonomous Region earlier this month. The well, the first one in the area, is located in the Junggar Basin, 100 kilometers east of Urumqi. [Text] [Beijing XINHUA in English 0716 GMT 11 Aug 87 OW] /12624

CSO: 4010/67

CHINA ACCELERATES WORK ON NUCLEAR POWER PLANTS

40130001 Beijing RENMIN RIBAO (OVERSEAS EDITION) in Chinese 13 Sep 87 p 1

[Text] Before the end of the century China will build PWR nuclear power plants with a total installed capacity of 10 million to 12 million kilowatts. In the latter part of the 1990's, China will add a new nuclear power plant every other year or two, increasing the role nuclear power will play in both the development of energy resources and the growth of the economy.

Peng Shilu, chief engineer of the Ministry of Nuclear Industry, revealed this plan to Chinese and foreign nuclear energy expert at the recently concluded "Sixth Pacific Rim Conference on Nuclear Energy." He further stated that the 300,000-kilowatt Chinese-designed Qinshan nuclear power plant now under construction should be on stream by the year 1990. Work on all phases of the Daya Bay nuclear power plant in Guangdong Province, being built as a joint project with Hong Kong and using foreign financing, is now under way. This plant's two 900,000-kilowatt reactors should be operational in 1992 and 1993 respectively.

Peng Shilu stated that based on a State Council decision, the second-stage project of Qinshan calls for the installation of two 600,000-kilowatt PWR reactors. This project is on the agenda of the "7th 5-Year Plan." In the research, design, and construction stages, foreign advanced technology and experience will be assimilated and used to the utmost.

This nuclear expert also revealed that in the 1990s, a low-temperature heat-supply demonstration reactor will be built in north China and an effort made--depending on need and feasibility--to have this kind of reactor operational before the end of the century. An all-out effort will be made to develop light water reactors, fast breeder reactors, high-temperature gas-cooled reactors, and fusion-fission reactors. The incorporation of advanced light water reactor technology into nuclear power plants will be attempted before the end of the century as will the construction of an experimental fast breeder reactor of 50,000 to 100,000-kilowatt capacity. Also within that time frame, a small-scale high-temperature gas-cooled reactor will be built if conditions permit.

09599

GEOPHYSICAL SURVEYS HELP DETERMINE SITES OF HANGZHOU BAY NUCLEAR POWER PLANTS

Beijing WUTAN YU HUATAN [GEOPHYSICAL AND GEOCHEMICAL EXPLORATION] in Chinese Vol 10, No 3, 10 Jun 86 pp 161-170

[Article by Liang Naijie [4731 0035 2638] of the Zhejiang Province Bureau of Geology and Mineral Resources: "Geophysical Surveys for Nuclear Power Plant Site Selection on Hangzhou Bay"]

[Text] Abstract

This article mainly introduces the situation in geophysical survey work for site selection for the three nuclear power plants to be constructed on the northern shore of Hangzhou Bay. The article focuses on the geophysical tasks and the main problems to be solved during the three stages of nuclear power plant site selection, it presents the results of using integrated geophysical methods to deal with regional and deep-seated geological structures, fractures of all types (including regional fractures and active fractures), seismic activity, measurements of the parameters of rock and soil body dynamics at the plant sites and other aspects, and it analyzes the question of whether or not the northern shore of Hangzhou Bay is a suitable site for nuclear power plants.

Hangzhou Bay nuclear power plants is the general name assigned to the three nuclear power plants to be located within 50 kilometers of the northern shore of Hangzhou Bay. Geophysical survey work has been carried out to varying degrees for each of the three stages of work involving systematic selection of areas, planned selection of islands and project site selection, and there has been widespread collection and utilization of various types of historical data on geophysical exploration and natural seismology based on the content and requirements of work during the three stages of nuclear power plant site selection to provide the corresponding results. Although the geophysical surveys (including natural seismic surveys, as below) were not carried out in complete accordance with procedural systems for geological, hydrological engineering geology and other work (some participated only in certain single stages of specialized surveys), the overall situation is one in which geophysical data were used during each stage of site selection and they played an important role. We now provide a summary of

geophysical exploration work for the three nuclear power plants based on the requirements of the overall nuclear power plant site selection process as a reference for future work.

I. Geophysical Survey Tasks During Nuclear Power Plant Site Selection and the Main Problems To Be Resolved

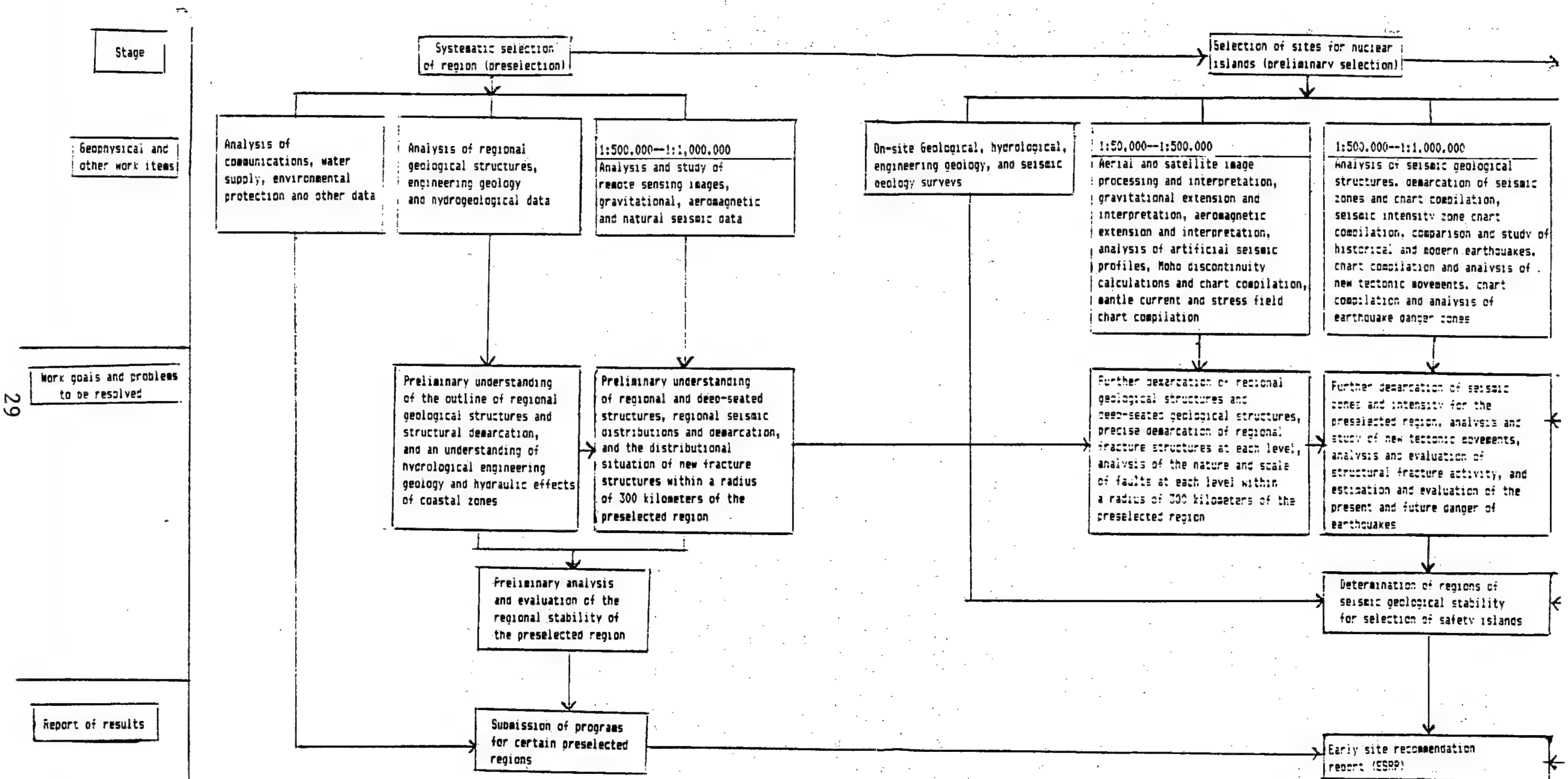
Systems engineering methods are used to outline the geophysical work involved for the three plant sites in Table 1.

The geophysical work involved during systematic selection of site areas was based mainly on the need to eliminate criteria to determine whether or not there were large deep fracture zones and ringlike structures along the coast within the preselected 320 kilometer region; whether or not there were dangerous regions (zones) of new structural activity; the historical regions (zones) of intense earthquake and regions (zones) of concentrated micro-seismic activity during modern times and other requirements. Answers to these questions could be obtained simply by analyzing and utilizing past geophysical results, so there was no need for on-site surveys. Moreover, large amounts of field surveys and integrated data research were carried out during the preliminary selection and project site selection stages. The current stage mainly involved the use of surveys and analysis of past and present seismic tectonic movements to demarcate and evaluate the crustal stability of the region within an 8 kilometer radius of the site, to make predictions and estimations for the present and future (over the next 50 years or so) on the basis of regularities in past and recent seismic activity, and finally to reach the goal of selecting a relatively stable land mass--the safety island. The main issue during project site selection was to develop surveys of tectonic movements and especially to gain an understanding of post-Quaternary active faults to provide data for evaluating the stability of the plant sites. In addition, it also was necessary to make measurements of various types to supply the parameters of soil and rock mechanics for project designs.

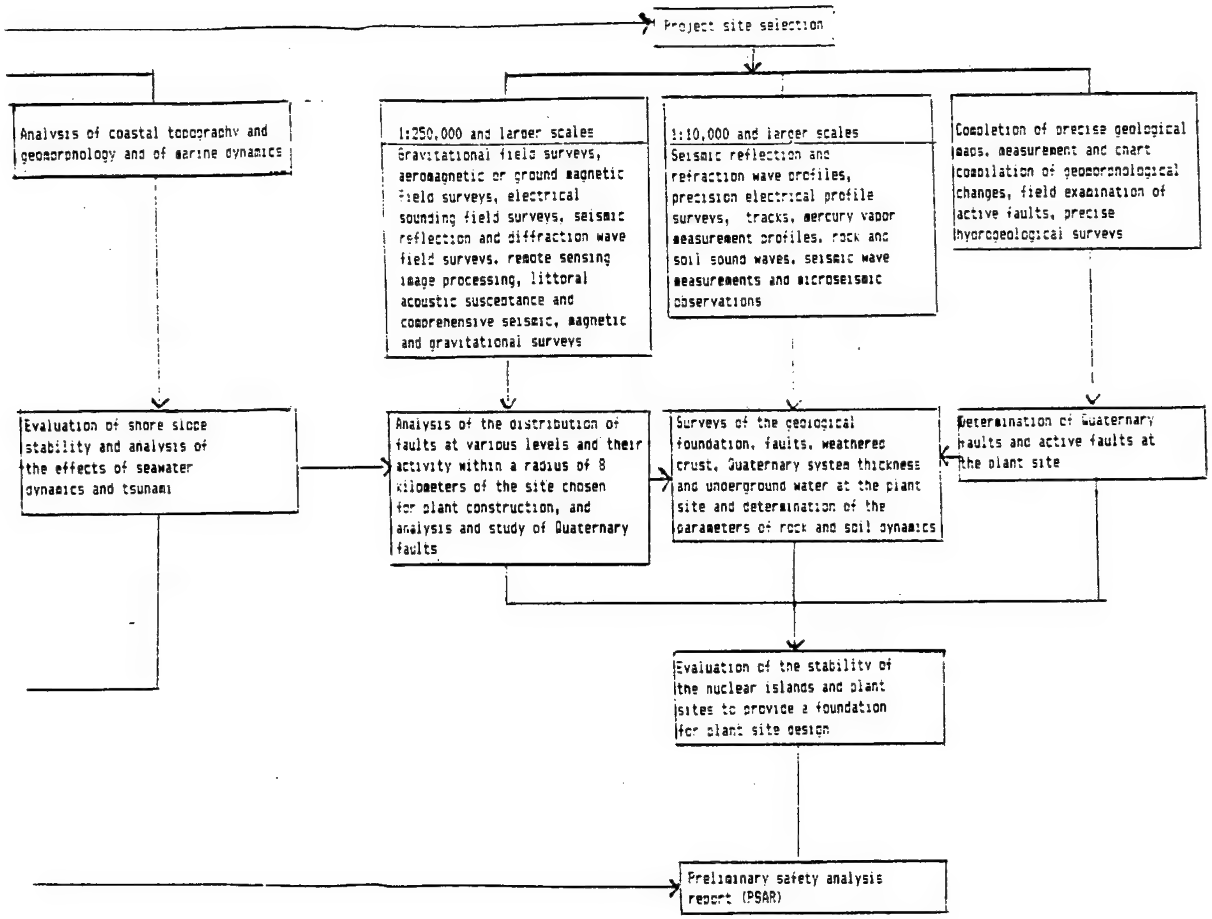
II. Analysis of Geological and Geophysical Questions

To evaluate the regional stability and plant site stability of nuclear power plants and to facilitate the selection of safety islands suitable for plant construction so as to determine the actual location of a plant site, the following geological questions must be resolved.

Table 1. Flow Chart of Geophysical Surveys for Nuclear Power Plant Site Selection on Hangzhou Bay



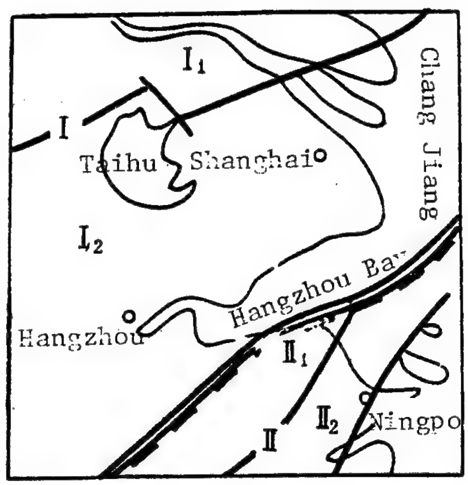
[Chart continued next page]


Project site selection
Analysis of coastal topography and geomorphology and of marine dynamics
1:250,000 and larger scales
Gravitational field surveys, aeromagnetic or ground magnetic field surveys, electrical sounding field surveys, seismic reflection and diffraction wave field surveys, remote sensing image processing, littoral acoustic susceptance and comprehensive seismic, magnetic and gravitational surveys
1:10,000 and larger scales
Seismic reflection and refraction wave profiles, precision electrical profile surveys, tracks, mercury vapor measurement profiles, rock and soil sound waves, seismic wave measurements and microseismic observations
Completion of precise geological maps, measurement and chart compilation of geomorphological changes, field examination of active faults, precise hydrogeological surveys
Evaluation of shore slope stability and analysis of the effects of seawater dynamics and tsunami
Analysis of the distribution of faults at various levels and their activity within a radius of 8 kilometers of the site chosen for plant construction, and analysis and study of Quaternary faults
Surveys of the geological foundation, faults, weathered crust, Quaternary system thickness and underground water at the plant site and determination of the parameters of rock and soil dynamics
Determination of Quaternary faults and active faults at the plant site
Evaluation of the stability of the nuclear islands and plant sites to provide a foundation for plant site design
Preliminary safety analysis report (PSAR)

1. Analysis of regional geological structures

Analysis of regional geological structures is the basis for evaluating the regional stability of power plants. A summary of geological and geophysical data indicates that Hangzhou Bay is located in the northern part of the Jiangnan [southern Jiangsu] fault-fold zone (second order)[1] where the Yangzi fault-block region and Huanan [South China] fault-fold system (level one) converge (Figure 1). It can be placed in the following categories based on the regional anomaly characteristics of the national 1° X 1° average gravitational anomaly map and the East China 1:1,000,000 aeromagnetic T anomaly map (Table 2). The numerical characteristics of the various material strata in Table 2 are shown in Table 3.

Figure 1. Geodesic Structural Outline Chart of the Hangzhou Bay Region



Key:
I. Yangzi fault-block region
   (I - Yangzi fault block, I - Jiangnan fault-fold zone)
II. South China fault-fold region
   (II - Wuyi-Yunkai fault-fold zone, II - Southeast coast fault-fold zone)

Table 2. Categories of Geological and Geophysical Regions in Hangzhou Bay

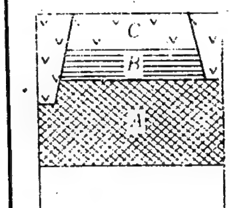
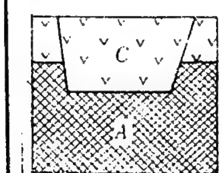
Geodesic structural demarcation		Gravitational field demarcation		Characteristic shape of basement			
Level One	Level Two	Region	Subregion	Horizontal shape of anomaly	Material strata	Illustration	Shape of basement
Yangzi fault-block region (I)	Yangzi fault block (I)	Yangzi positive gravitational field region	Nearly E-W oriented elliptical positive anomaly region	Rhombohedral	Three-strata structure		Convex
	Jiangnan fault-fold zone (I)		Northeasterly positive-negative short axis anomaly region				
South China fault-fold region (II)	Wuyi-Yunkai fault-fold zone (I)	South China negative gravitational field region	Northeasterly positive-negative belt-shaped anomaly region	Trough-shaped	Two-strata structure		Concave
	South China coastal fault-fold zone (II)		NNE-oriented positive-negative belt-shaped anomaly region				

Table 3. Parameters of Material Strata

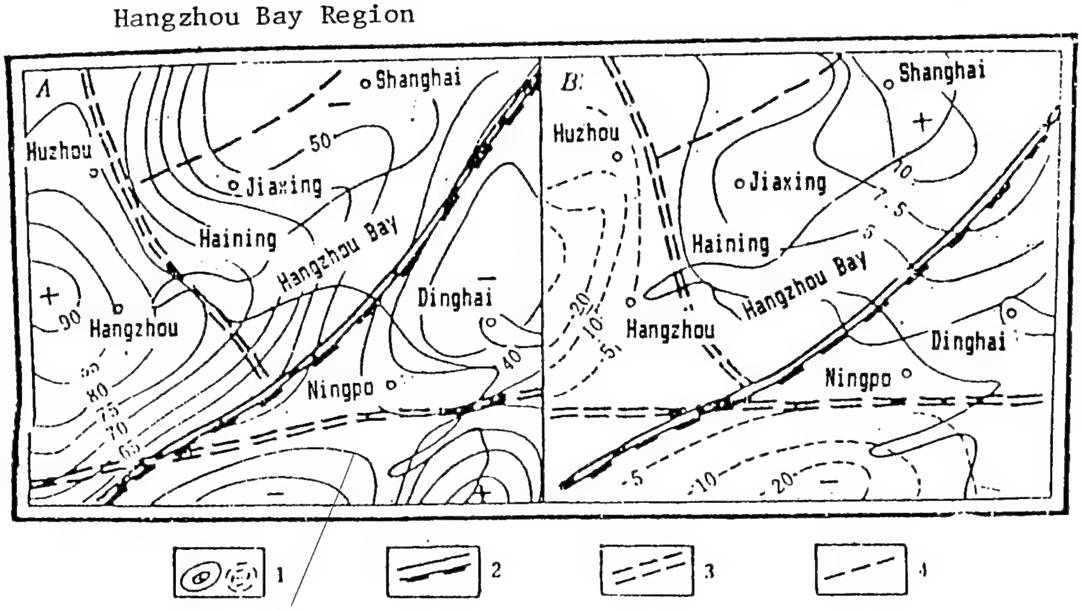
Material strata	Strata buildup	Material parameters		
		Intensity of magnetization (n 10^{-6}CGSM)	Density (g/cm^3)	Seismic wave velocity (kilometers/second)
C	Mesozoic-Cenozoic volcanic rock buildup	$10^2 - 10^4$	2.46	5.34
B	Paleozoic sedimentary rock buildup	$0 - 10^2$	2.63	5.95
A	Pre-Sinian system metamorphic rock buildup	$10 - 10^3$	2.69	6.13

As shown in Table 3, there are obvious characteristic differences among the different basement structures of each of the structural elements that are capable of creating anomalies of sufficient intensity. The regional fields in the area of the nuclear power plants display the following basic characteristics in gravitational and magnetic maps: in their horizontal distribution, the result of the strong effects of fixed regional tectonic movement--Yanshan movement--during later periods was that the strata of each era are characterized by fault-block jointing reflected in an anomalous pattern of a "rhombohedral sag-uplift" of interlaid structures. In their vertical distribution, the lithologic buildup and material characteristics of the strata of each era are such that they have the characteristics of a stepped structure that caused them to form a graded pattern of superposed anomalies. Because of different tectonic movements in each of the regions, this sort of structure with horizontal blocks and vertical steps made the formation of different anomalous group combination categories possible, which is the basis for our utilization of geophysical exploration data to demarcate structural zones. For example, the Yangzi fault-block region where the nuclear power plant island is located is a down-warp within a gentle positive gravitational regional field (a reflection of a grade one structure), and as such has the shape of a "sag within an uplift." Regardless of whether an "uplift" or a "down-warp" is the positive value, it is intrinsically different from the background of the negative value of the nearby Huanan fault-fold system. The former is secondary graben on an uplift in a basement of highly metamorphized pre-Sinian system rock, while the latter is a graben in a subsidence in a basement of lightly metamorphized pre-Devonian system rock. To satisfy the requirements of site selection for a nuclear island, it is unimportant whether it is on a "convex" or "concave" basement. Any plant site chosen that is on an integral land mass in a region of light intensity earthquakes more than 8 to 10 kilometers from a deep fracture will satisfy the requirements.

2. Research on deep geological structures

The main goal of exploring deep structures for nuclear power plant is to understand deep-seated geodynamic factors affecting regional stability and their role in controlling crustal geological structures. For this reason, gravitational and areomagnetic surveys were extended, and gravitational and seismic readings served as the basis for compiling Moho discontinuity and other depth charts. The results of calculations based on satellite gravitational measurements were used to compile a mantle convection stress field chart and other data for more comprehensive study. The results of gravitational surveys of Hangzhou Bay extending upward to eight elevations and aerȯmagnetic surveys extending upward to five elevations clearly indicate that the surface strata effects weaken and disappear as the elevation increases and that there is a prominent deep-seated structural outline. The aeromagnetic results moving 30 kilometers upward and the gravitational results moving 25 kilometers upward, for example, (Figure 2), indicate that all of the deep-seated structures of northern Zhejiang and the East China Sea continental shelf are characterized by fault-block interland structures. Hangzhou Bay is located in the southeastern part of the Hangzhou-Haining high positive gravitation and magnetism regional field and that the nuclear island was selected on the basis of a deep-seated and ancient stable mantle fault block as indicated by high gravity and magnetism and that the nearby area from the mouth of Hangzhou Bay to the sea around the Danshan Islands is a region of low negative gravity and magnetism, which indicates that there has been relative subsidence in the basement. The boundary between the two is the site through which the Jiang Shan-Shaoxing deep fracture (grade one) passes.

Figure 2. Gravitational and Magnetic Upward Extension Contour Map of the Hangzhou Bay Region



Key:
A. Aeromagnetic charts (extended upward 30 kilometers, units = T)
B. Gravitational chart (extended upward 25 kilometers, units = mGal)

1. Positive-negative gravitational contours
2. Crustal deep fractures
3. Basement fractures
4. Capping strata fractures

The Moho discontinuity and other depth charts indicate that there are no major rises in the Moho discontinuity throughout the vast region of southern Jiangsu, northern Zhejiang and the northern part of the East China Sea continental shelf region, and that it takes on an almost planar distribution. It is buried at a depth of about 29 to 30 kilometers and has no apparent cascade zones or prominent local sags or uplifts. Hangzhou Bay is located in this sort of stable deep environment, whereas there are rather large uplifts in the Moho discontinuity in the adjacent Huanan fault-fold system region that form a "boat-shaped" distribution along a northeasterly axis at a depth of 35 to 40 kilometers. The differences in the shape of the Moho discontinuity indicate the deep structural differences between the two major geostructural components.

Mantle flow stress vectors were calculated according to the geogravitational geolocation harmonic function coefficient announced by the American Flight Center and the mantle convection and stress equation extrapolated by S. K. Runorn. The formula is as follows:

$$\sigma_E(\theta,\lambda)=\sum_{n=26}^{30}\sum_{m=0}^{m=n}\frac{Mg}{4\pi a^2}\left(\frac{a_0}{a}\right)^{n+1}\frac{2n+1}{n+1}\;\frac{1}{\sin\theta}P_n^m\cos[-m\,\bar{C}_{n,m}\sin(m\lambda)$$
$$+m\bar{S}_{n,m}\sin(m\lambda)]$$

$$\sigma_N(\theta,\lambda)=\sum_{n=26}^{30}\sum_{m=0}^{m=n}\frac{Mg}{4\pi a^2}\left(\frac{a_0}{a}\right)^{n+1}\frac{2n+1}{n+1}\;\frac{d}{d\theta}[P_n^m(\cos\theta)][\bar{C}_{u,m}\cos(m\lambda)$$
$$+\bar{S}_{n,m}\sin(m\lambda)]$$

In the formula, $\sigma_E(\theta,\lambda)$、$\sigma_N(\theta,\lambda)$ are the eastward and northward components of mantle flow stress, M is earth quality, g is gravitational acceleration, a_0 is the radius of the earth, a is the radius of spherical upper boundary of mantle flow, λ is longitude, θ is colatitude, $P_n^m(\cos\theta)$ is the associated Legendre polynomial of θ for the nth stage of the mth argument, and $\bar{C}_{n,m}$ and $\bar{S}_{n,m}$ are the gravitational geolocational global harmonic function coefficients.

Stress values for 26 to 30 stages were calculated by computer to compile a vector distribution chart (Figure 3) based on the results of joint stress:

$$\sigma(\theta,\lambda)=[\sigma_E^2(\theta,\lambda)+\sigma_N^2(\theta,\lambda)]^{\frac{1}{2}}$$

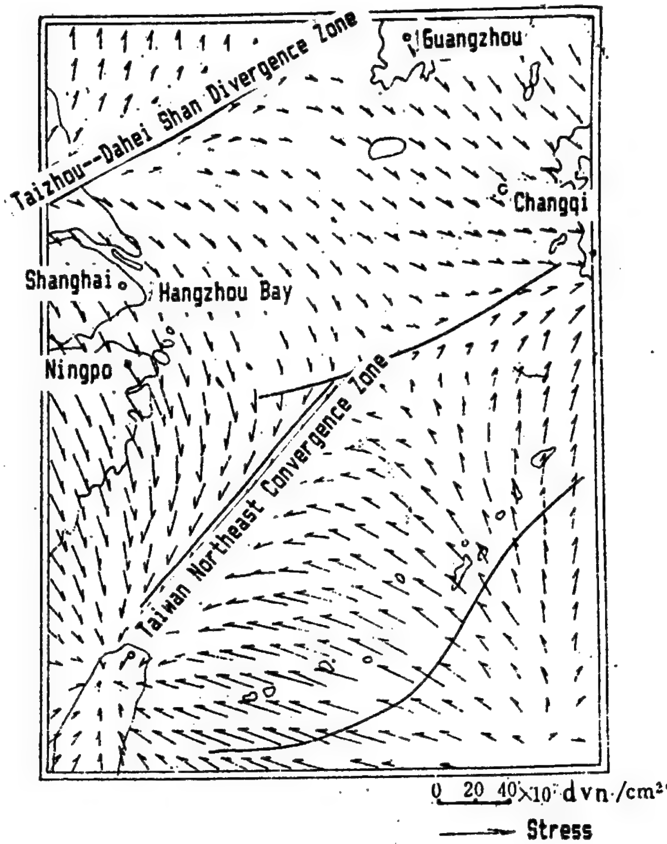
and direction:

$$\alpha(\theta,\ \lambda)=\mathrm{tg}^{-1}[\sigma_N(\theta,\lambda)/\sigma_E(\theta,\lambda)]$$

It is apparent from the higher order (26 to 30 stages) stress field vector chart showing upper mantle currents that the entire East China Sea continental shelf is located between the southern Yellow Sea extension zone (Taizhou--Dahei Shan) and the Taiwan northeastern convergence zone in a

stable transition zone of downward convergence and subduction and of upward dispersion and extension of mantle currents, with Hangzhou Bay located in the middle, far from active zones that engender deep and shallow sources of earthquakes, and that it is a region of stable mantle flow.

Figure 3. Higher Order (25-30) Mantle Flow Stress Chart for the East China Sea



(According to the State Bureau of Oceanography No 2 Institute)

The results of precise determinations of earthquake locations in recent years (1964-1983) show that the projections of seismic foci often are identical with the margins of regions of mantle uplift, sites of obvious changes in gravitational equilibrium states, and near centers of convergence and divergence in higher order mantle current stress fields. There is no doubt that these locations are closely related to deep-seated geological structures and that they are controlled by them.

3. Survey and demarcation of fault (fracture) structures at each level

Nuclear power plants place very strict demands on fault surveys. The goal is to determine the distribution of active faults to provide a foundation for evaluating the stability of regions and nuclear island projects. Fault surveys can be divided into the three classes of far-site, near-site and on-site surveys. There are three clear stipulations regarding the technical scale of nuclear power plants:

(1) Stipulations regarding the minimum necessary length of faults based on the distance of faults from the plant site;

(2) Stipulations regarding the minimum scale of surveys for project areas based on the magnitude of earthquakes and the width [of the area] controlled by a fault;

(3) Stipulations regarding the requirements for surveying active faults based on the intensity of earthquakes, and so on.

In accordance with these stipulations, geophysical exploration fault (fracture) surveys can be divided into two main categories:

(1) Surveys of regional fractures.

The goal is to determine the distribution of regional fractures of each grade within a radius of 320 kilometers of the plant site to provide a foundation and basic data for selection and evaluation of the regional stability of nuclear islands and compilation of charts demarcating the danger of earthquakes. By using geophysical results as a foundation and integration with geological and seismic data, the regional fractures in the Hangzhou Bay region can be divided into the three classes of capping strata fractures, basement fractures and crustal fractures (no lithospheric fractures pass through the region). The primary characteristics are shown in Table 4.

Using earthquakes with the potental for definite destruction ($4\frac{1}{4} \leq M_s \leq 6\frac{3}{4}$) as the standard, historical earthquake epicenters were projected onto the geophysical map. It is obvious that earthquake epicenters are controlled by the following four types of geophysical fields:

a. Cenozoic fault-uplift or fault-subsidence interchange zones controlled by crustal fractures or basement fractures. They also are subject to NNE and NW-oriented active fault facies to form sites of regional gravitational and magnetic cascade zone distortions or mutations;

b. By the steep side at the margin of Cenozoic fault-uplifts or fault-subsidences surrounded by subsidences sounded through gravitational and electrical means in regions of dense gravitational and apparent resistivity contours; or in where two groups of NWW-NNE conjugate deep fractures join to form two types of field superposition;

c. Gravitational and magnetic upward extensions that are displayed as the margin between two block fault-shaped positive and negative fields, or near second-order derivative gravitational and magnetic anomaly zones;

d. Higher order (26, 30 level) primary mantle force field vector convergence (downward) or dispersion (upward) zones.

Without a doubt, the four anomalous locations listed above are closely related to earthquake epicenters as well as indicators of the locations of regional fractures.

Table 4. Classification of Regional Deep Fractures in the Hangzhou Bay Region

Category	Depth of cut	Geological indicators	Geophysical indicators	Control of crustal activity	Active period	Representative fracture
Capping strata fractures	Cuts through sedimentary rock into the top of the crystalline basement.	Faulted and deformed volcanic and sedimentary rock strata locations lacking igneous rock zones	Zones of dense gravitational, magnetic and resistivity contours, ring-shaped and bead-shaped axial lines of magnetic anomalies, discontinuous seismic wave velocity mutations and reflection surfaces, zones of linear distributions of natural seismic epicenters, indications of geomorphological and geological factors in remote sensing images	No control or control of weak seismic activity	Intense activity during the Yanshan period and continuing activity since the Neogene era	Xiaoshan-Qiuxhou fracture
Basement fractures	Cuts through the entire granitic strata (salic strata) to the top surface of basaltic strata (Kahn plane)	Cenozoic lakes and spring point lines in Mesozoic and Cenozoic fault-subsidence basins, with acidic igneous rock distributed along the interior of fractures	Regional gravitational and magnetic field demarcation lines, large gravitational and magnetic cascade zones, zones of abrupt changes in gravitational and magnetic extension contours, discontinuous strata of seismic reflection waves, linear distributions of natural seismic epicenters, large linear remote sensing images	Seismic zones that control small and medium-intensity earthquakes (M >4) and distributions of low-temperature geothermal water	Fractures produced during the early part of the Sinian era with continuing activity during the Yanshan period	Jinghua-Yuyao deep fracture
Crustal fractures	Cuts through the entire crust into the top of the mantle (Moho plane)	Ultrabasic rock found in fractures (continental tholeiite and gabbro) with lightly metamorphized zones	Regional gravitational and magnetic field demarcation lines, large gravitational and magnetic cascade zones, dense gravitational and magnetic extension as well as Moho plane contours, interrupted seismic reflection waves and zones of deep-focused natural earthquake epicenters, zones of high order mantle current stress field convergence or divergence	Zones that control moderately strong and strong earthquakes (M 6)	Fractures produced during the Protozeroic with extremely weak activity during the Mesozoic and Cenozoic eras	Jiangshan-Shaoxing deep fracture zone

(2) Surveys of active fractures

Active fractures in the technical stipulations for nuclear power plants refer to a minimum occurrence of one surface or near-surface or near surface movement during the past 3,500 years or faults in which repeated activity has occurred over the past 500,000 years. Surveys of active fractures are a key item in evaluating nuclear power plant sites. This is especially true of the key question of investigating fault activity within a radius of 8 kilometers.

The focus of surveys of active fractures near the site of the Hangzhou Bay nuclear power plants is on Quaternery faults, especially those fractures active throughout and after the Cenozoic. Their content includes surveys of structural activity and surveys of seismic activity.

a. Surveys of structural activity

These mainly involve large and medium scale aerial geomagnetism, gravitation, electrical sounding, shallow marine strata profiles and other measures for regional surveys. Shallow strata seismology, electrical profiling, tracks, mercury vapor measurements and other profiles are used for precise locational determination and demarcation to understand the distribution of fractures at different scales. The main problems to be solved are:

(a) To understand the shape of basement structures within a radius of 8 kilometers and the distribution of faults more than 1.5 kilometers long. Because the primary basement elements in this region are formed of interlain magnetic volcanic rock and non-magnetic limestone, primary reliance on magnetic surveys in conjunction with the results of seismic, gravitational and electrical surveys to demarcate basement fractures and structural shapes was quite effective;

(b) Based on vertical magnetization anomaly charts after chemical polarization, iso-apparent resistivity profiles, a tracks and mercury vapor measurements, we made rather precise determinations of the location of faults and gained an understanding of the shape, occurrence and separation of faults as well as their relationship with regional active fractures;

(c) The region has obvious characteristics of new and old control and continuity. Paleozoic basement fracture structures, for example, controlled the formation of Mesozoic and Cenozoic red bed basins or volcanic basins, and Mesozoic and Cenozoic fracture structures controlled the accumulation and development of Quaternary strata. Based on the results of a suite of gravitational and magnetic extensions moving from shallow to deep areas, an understanding was gained of the evolution of the structures at various levels and the depth and developmental history of fault dissections, as well as whether or not there are macro-level indicators of the controlling functions of new tectonic movements and so on. For example, there were obvious indications of the effects of Wa Shan nappe structures (Paleozoic strata overriding Mesozoic and Cenozoic strata) on Quaternary sedimentation

in gravitational measurements and electrical soundings; shallow strata profilers were used to determine the effects and roles of various types of deep sea trenches (and gulleys) on the formation and development of Quaternary sedimentation and so on;

(d) Direct and indirect exploration of Quaternary faults, such as the use of electrical and seismological methods to study mutations in Quaternary system thickness, discontinuities in certain indicator strata (like the reflective strata at the bottom of the Pleistocene system) and the displacement, absence and obliqueness of marine Quaternary system reflective strata and so on for additional assessments;

(e) Direct readings of Quaternary system strata based on aerial and satellite photographs or satellite photographs using computers for information reinforcement and image enhancement processing, the use of the 4, 5 and 7 waveband values to make histograms for isostatic false color synthesis to reveal linear structures in the images, deduction of Quaternary system faults and on-site investigation and confirmation;

(f) Research on the role of deep-seated geological and geophysical structural strata in restricting and controlling seismic activity in temporal and spatial terms based on precise horizontal and depth locational determinations of the seismic foci of historical and modern earthquakes to provide basic data for demarcating earthquake intensity and studying the effects of future seismic activity.

In addition, we also collected and utilized data on grade II and III benchmark elevations in past standard measurements to compile topographic contour maps to gain an understanding of surface uplifts, investigate the existence of new tectonic movements and thereby gain an understanding of their intensity, distribution, qualities and so on.

After completing the work outlined above, the overall feeling was that the Hangzhou Bay nuclear island region is a stable region that lacks intense new tectonic movements and active Quaternary system faults.

b. Survey and estimation of seismic activity

The primary goal of seismic activity surveys is to provide a basis for the design of earthquake-resistent nuclear power plants, which requires basic data concerning surface vibrations caused by earthquakes. This requires intensive examination of seismic and geological structural phenomena during the process of filling in geological charts for areas near plant sites as well as examinations of the area of destruction for the largest historical earthquake within the region (like Liyang [county in southern Jiangsu Province]). On this foundation and based on data on past earthquakes and on recent seismic activity obtained from the seven seismological stations within the regional net, we compiled regional epicenter distribution charts, isoseismic line charts, seismic zone demarcation charts and earthquake intensity demarcation charts. Finally, we compiled a chart outlining regions of earthquake danger. Based on analysis of these data and charts, the focus was placed on resolving these two problems:

(a) Studying the relationship between historical earthquakes and the geological structure of the region, especially the relationship with active faults, to analyze the danger of earthquakes and to calculate the depth of seismic foci, earthquake magnitudes, categories of seismic foci and the scale and speed of fault destruction;

(b) Estimation of the probability and periods of future earthquake recurrence in the region based on the distributional characteristics of historical earthquakes as well as determination of the intensity of effects on the plant sites to estimate the degree of earthquake destruction within the next 100 years.

The results of statistics compiled on past earthquakes in the region covering the years 499 to 1983 are shown in Table 5.

Table 5. Statistics on Historical Earthquakes in Hangzhou Bay

Number of earthquakes throughout history (499 to 1983)				Greatest earthquake magnitude (M_s)	Maximum intensity (I_0)	Period of greatest energy release (years)	Maximum amount of energy released ($10^7 erg^{\frac{1}{2}}$)	Depth of seismic focus (kilometers)
Total	$M_s < 3$	$3 - 4\frac{1}{4}$	$4\frac{1}{4} - 6\frac{3}{4}$					
505	413	59	33	$6\frac{3}{4}$	VII	12 - 22	23.974	20 - 25

(Based on data compiled by the Jiangsu Province Bureau of Seismology)

Earthquake epicenter distribution charts and earthquake region demarcation charts compiled by the Jiangsu Bureau of Seismology indicate that the following regularities in seismic activity are found in the region:

(a) In terms of its regional distribution, Hangzhou Bay is located within the Shanghai-Shangrao earthquake zone that has had 11 earthquakes throughout history (one of them at sea), the greatest having a magnitude of 5. The nearby southeastern coastal earthquake subzone has had six earthquakes throughout history (two of them at sea), with the largest having a magnitude of $5\frac{1}{2}$. The entire region is one of weak seismic activity. Predictions of future earthquakes in the region indicate that the area is located in the Shanghai-Hangzhou grade-5 latent seismic focus region and the fracturing zone is a grade VI region.

(b) In temporal terms, there have been five active periods of seismic activity in recent times, each period being about 125 to 150 years long, including destructive earthquakes (major strain release energy stage) during 2 years separated by a period of 12 to 22 years. The total amount of accumulated strain released during each period varies over a range of 21.648 to 46.198 x 10^9 erg$^{\frac{1}{2}}$. The region currently is in its fifth period

(1971 to 2000). As for the strain energy, released, this period of activity already has released strain energy of 5.83×10^9 erg* (1971). The prediction is that strain energy of a magnitude of 4.9 to 5.8 remains to be released and that the period of danger is 1986±2 years and 1995±3 years. As for the Hangzhou Bay nuclear power plants, the latter period of danger deserves a high degree of attention.

4. Preliminary determination of the rock dynamics parameters at the plant site

The bedrock at the site of the three power plants is Jurassic system volcanic rock and the lothology is primarily crystal fragment tuff lava. To gain a preliminary understanding of the rock dynamics at the sites of the plants to be constructed, the East China Academy of Electrical Design used the Bison 1580-2 multichannel engineering seismograph and the Syc-2 rock parameter sonic analyzer in field and laboratory tests of V_p (compressed waves) and V_s (shear waves). The results obtained using the formula below provided the elasticity modulus E_d and the moving shear modulus G_d:

$$\mu = \frac{\left[1 - 2\left(\frac{V_s}{V_p}\right)^2\right]}{\left[2 - 2\left(\frac{V_s}{V_p}\right)^2\right]}$$

$$E_d = \rho V_p^2 (1+\mu)(1-2\mu)/(1-\mu)$$

$$G_d = E_d/2(1+\mu)$$

The ρ in the formula refers to the Poisson ratio while the refers to the rock density parameters. The figure of 2.8/1000g ($kg \cdot second^2/cm^2$, g being gravitational acceleration) was adopted based on experience.

The results shown in Table 6 were obtained after blasting at 96 points in the field and laboratory measurements of 51 rock core samples.

Table 6. Measurements of Bedrock V_p and V_s at the ZP Plant Site

Type of measurement	V_p (meters/second)	V_s (meters/second)	μ	E_d ($10^4 kg/cm^2$)	G_d ($10^4 kg/cm^2$)
Field rock bodies	3,400 - 3,900	1,800 - 2,400	0.27 - 0.30	25 - 34	10 - 15
Rock cores and samples	5,000 - 6,500	2,700 - 3,000	0.27 - 0.31	53 - 65	21 - 25

(Note: The field measurements are rather close to real ones and are the final figures, while the rock core measurements are reference figures.)

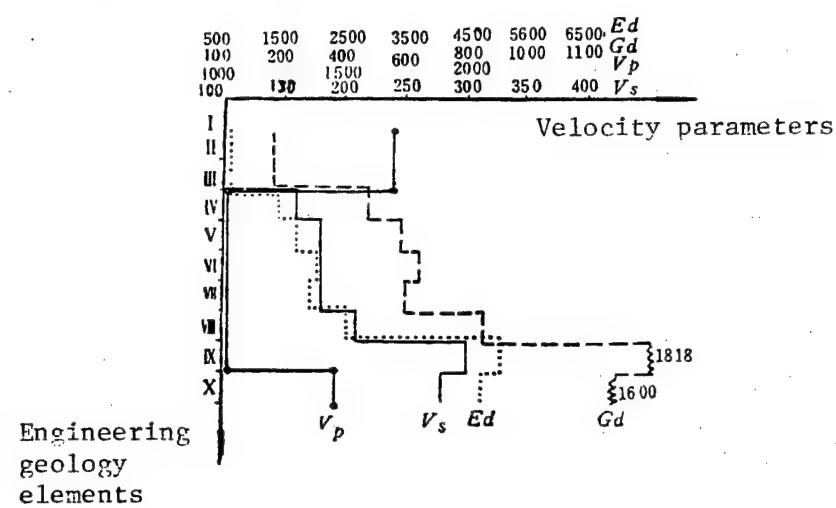
In addition, measurements were taken of weathered bedrock, with the results being V_{p2}= m/s, V_s = 2200 m/s, μ = 0.25, E_d = 33 x 10^4 kg/cm^2 and G_d = 13 x 10^4kg/cm^2. The parameters of the weathered rock were slightly smaller than those of fresh rock bodies.

In order to achieve a matchup with Quaternary system engineering geology elements, dynamic parameters were derived for each ofthe components. Percussion pile strata testing methods and electric sparks and shear hammer activated cross-hole methods were used to measure vertical and horizontal waves. At the JS plant site, for example, eight bore holes 5 to 10 meters apart with an effective depth of 75 meters permitted the derivation of data on P and S waves for the I-X engineering geology elements. After making these measurements, it was felt that:

First, data on strata velocities and differentials of the P and S waves of each element corresponded excellently with the lithology and soil body structures. Their numerical regularities were: silt < silty clay < fine powdered sand < light clayey soil and clayey soil, with S waves that tend to increase at greater depths and P waves that are relatively stable.

Second, the results of parameter measurements (Figure 4) indicate that load-bearing strata for the shallow foundation should start with stratum IV. Stratum VI is the optimum, with G_d = 641 kg/cm^2 and E_d = 1902 kg/cm^2. The top is buried at a depth of 17.65 meters andits average thickness is 2.25 meters. It is a light clayey soil stratum. The load-bearing strata for the deep foundation begin with stratum VIII. The optimum is stratum IX, with G_d = 1818 kg/cm^2 and E_d = 5275 kg/cm^2. It is buried at a depth of 49.11 meters, has an average thickness of 4.16 meters and is a clayey soil stratum. There are, of course, good load-bearing strata at greater depths. In summary, based on design requirements and considerations of economic rationality, the four VI, VII, VIII and IX elements can be selected for use.

Figure 4. Soil Dynamics Parameters at the JS Plant Site



To serve as a basis for project design, apart from the above use of geophysical methods to derive data on the in situ dynamic parameters of the strata, we also had to carry out measurements of several physical dynamics parameters to satisfy design requirements.

Conclusions

The results of a great deal of geological and geophysical surveys indicate that Hangzhou Bay is a relatively ideal region that can be used for the selection of an island to construct the plants. It has the basic conditions of regional and plant site stability and meets the requirements for the prediction of present and future seismic activity. During the site selection feasibility discussion stage, it provides the basis for the compilation of a preliminary safety analysis report (PSAR).

The geophysical survey of Hangzhou Bay enlightened us in two areas:

First, there are definite benefits to the use of geophysical methods to solve the various geological problems involved in nuclear power plant site selection. This is especially true of littoral plain regions with rather thick Quaternary regoliths, in which case geophysical surveys are indispensable. Because of the special demands of the geological questions that must be dealt with for nuclear power plants, emphasis must be placed on the appropriateness, flexibility and synthetic nature of the methods utilized.

Second, given the seriousness of the work involved in nuclear power plant site selection, the results provided must be accurate and conservative and the final conclusions must be reliable in terms of their ability to be tested in practice in the future. For this reason, attention to the quality of the original information and data in each aspect of the surveys is a basic question and should receive a high degree of attention from start to finish. At the same time, attention first of all must be paid to the utilization of directly effective methods to solve the various geological questions and full use should be made of the role of integrated methods as well as to the most appropriate processing of the data that is obtained to reduce as much as possible the multiple solutions to deduction and interpretation.

This article employed data from the Zhejiang Province Bureau of Geology and Mineral Resources, the Jiangsu Province Bureau of Seismology, the Ministry of Geology and Mineral Resources Aerial Geophysical Survey Team and the East China Electric Power Design Academy, for which we would like to express our deepest gratitude!

REFERENCE

1. Zhang Wenyou [1728 2429 0147], Chief Editor, ZHONGGUO JI LINGQU DADI GOUZAO TU [Tectonic Map of China and Nearby Areas], Science Press, [Beijing], 1983.

12539/9604
CSO: 4008/87

FEASIBILITY STUDIES ON URBAN NUCLEAR HEATING PLANTS APPROVED

HK150726 Beijing RENMIN RIBAO in Chinese 14 Aug 87 p 1

[Dispatch by reporter Wei Yanan (7614 0068 0589): "Heating Plants Using Nuclear Energy To Be Built in Qiqihar and Lanzhou"]

[Text] There is a new development in the use of nuclear energy in China--a new sphere is being opened up in field of making use of nuclear energy in heat supply. Recently, a feasibility report on establishing nuclear energy heating plants in China's large and medium cities, which will use nuclear energy instead of coal or oil, was approved. It held that there are broad prospects for establishing nuclear-energy heat stations in China, especially in northeast, northwest, and north China. The nuclear energy heat reactor designing technology of relevant departments is advanced, safe, and reliable, the comprehensive economic results are remarkable, and the plan is feasible. Qiqihar, in northeast China, and Lanzhou, in northwest China, have been selected as the cities were the first two nuclear energy plants will be built. Preparations are now being made for the first stage of designing for the two projects in these cities.

Consumption of heat energy comprises a large proportion of total energy consumption. Since 1985, on the basis of summing of the experience of successfully designing and building nuclear projects and absorbing modern, advanced technologies of using nuclear energy in heat supply, the Second Design Institute of China's Ministry of Nuclear Industry has been cooperating with Sweden in studying and designing a model reactor. This is a kind of pressurized, pool-shaped, low-temperature and intrinsically safe reactor, which will be used as a model for heat-supply reactors in nuclear heat plants. It is regarded as the safest and most promising new model at present. With the intrinsic safety of thermal power and hydropower, even when something goes wrong without the operators' knowledge, the reactor will shut down automatically and bring out the remaining heat safely and reliably. Accidents such as those that happened at Three Mile Island of the United States and Chernobyl in the Soviet Union will never happen with such a reactor. Therefore, it can entirely replace boilers and can be built in the suburbs of large and medium-sized cities to supply heat and industrial steam. It can also further increase thermal power parameter and be developed into a station jointly supplying heat and electricity, such as a nuclear heat and power plant or a nuclear power plant.

A 400,000-kilowatt low-temperature nuclear heat supply reactor can replace nearly 1,000 boilers, solving heat problems of a city with a population of 500,000 to 600,000. Moreover, some 500,000 metric tons of coal can be saved and some 10,000 cars can be reduced in railway transport. Nuclear heating plants do not need large slag discharge yards because they do not discharge dust and dirt and other pollutants such as sulfur dioxide and oxidized nitrogen. Thus, the problem of environmental pollution can be for the most part solved. Today, many cities have requested nuclear heating plants. However, the problem of investment should first be resolved. for this reason, it is impossible to popularize the use of nuclear heat in the near future.

/12232
CSO: 4013/90

STATUS OF BIOMASS R & D IN CHINA REVIEWED

Chongqing XIN NENGYUAN [NEW ENERGY SOURCES] in Chinese No 6, 5 Jun 87 pp 33-35

[Article by Xu Haixing [1776 3189 1840] of the Wuhan Municipal Energy Science and Technology Research Institute]

[Excerpt] I. Dynamics of Biomass Research in China

In recent years, Chinese biomass research has issued from system ecological principles, with the resolution of village energy as central. It has used multifaceted and multidirectional methods to synthesis organically the areas of energy, fertilizer, and feed to advance from obtaining single energy benefits to gaining total advantages simultaneously in energy, environment, ecology, and the economy. The total utilization of biomass includes: (1) total utilization of straw and stubble to grow mushrooms - feed - underground methane pools; (2) comprehensive use of methane to incubate chicken eggs, nurture seedlings, rear silkworms, in drying, and generating electricity; and (3) total use of methane residue in growing mushrooms, aquaculture, raising yellow ells and earth worms, and as feed.

The Chinese Academy of Sciences' Chengdu Biological Research Institute set up the "Chengdu-Shuangliu New Energy Demonstration Village." Adopting new dry-wet fermentation techniques, they popularized low-pressure methane cook stoves and the Chinese Science and Technology University's KG-II model improved wood-saving stove. The average thermal efficiency of the wood-saving stoves reached 18 percent, reducing consumption by 40 percent.

Up to now, using waste matter as well as human and animal excrement, China has built large, medium, and small-scale methane gas works at over 1,000 locations. Of these, there have been successful experiences at wine making factories, animal feed lots, etc. Amylum factories, citric acid factories, synthetic fatty acid factories and others have already mastered special techniques of waste water anaerobic digestion treatment.

In 1985, the Sihong brewery in Jiangsu imported Australian industrial methane gas technology. Placed in operation in 1986, the processing flow is shown in the accompanying figure. This technology uses mid-range temperature fermentation; in three-stage processing, the detention period is 6 and 1/2 days, and production operation is entirely automated. The

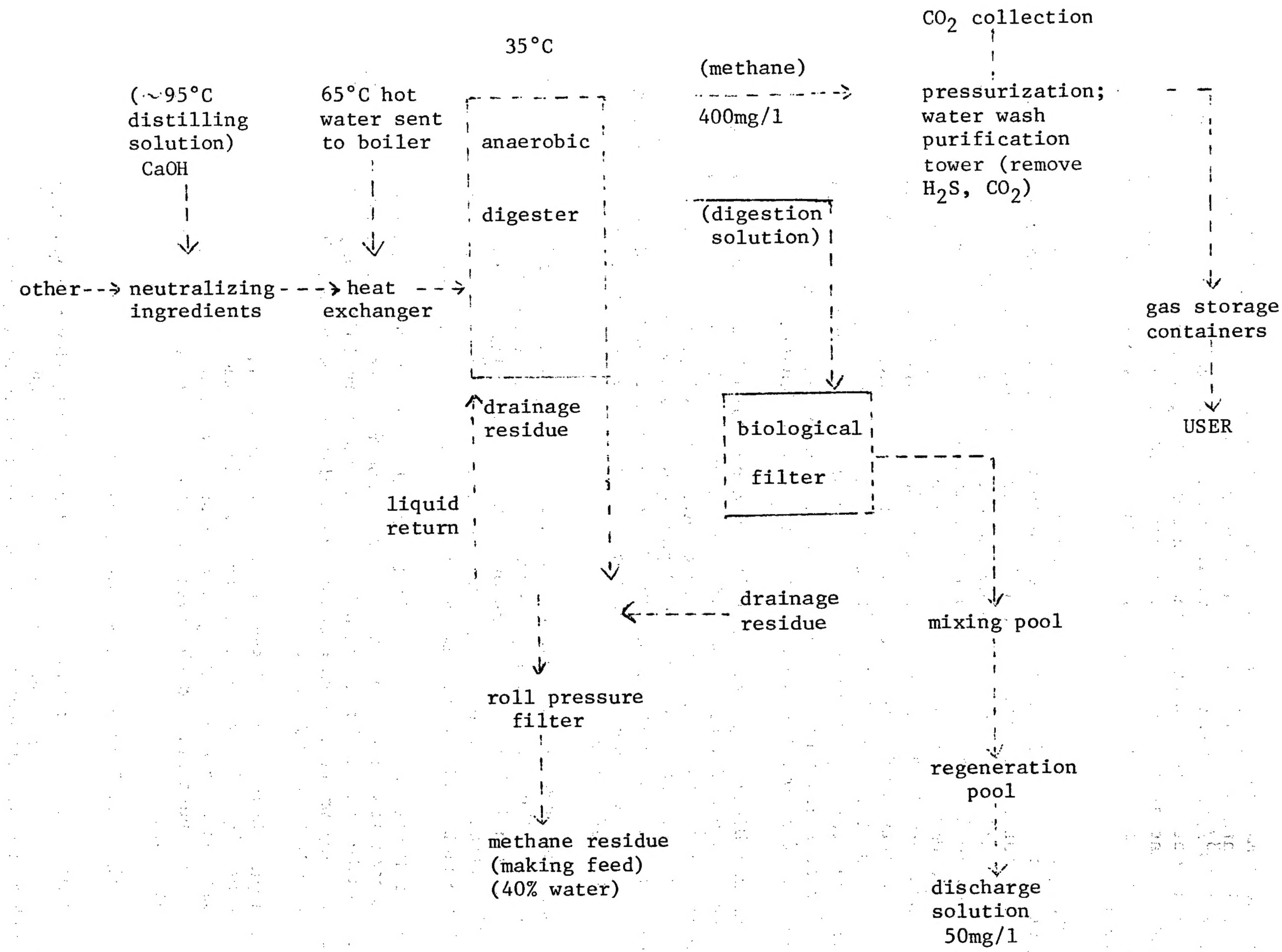


Diagram of Operation

technoeconomic norms of the design are: digester capacity $1,000m^3$, aerogenic rate $4.3m^3/m^3 \cdot day$, methane production output $4,300m^3$/day ($142 \times 10^4 m^3$/year, with 330 operating days/year), raw material aerogenic rate $28m^3$/metric ton, daily processed distilling solution 150 metric tons, input dry matter concentration 4 percent, COD value 4.5×10^4mg/liter (input) and 50mg/liter (output), and waste water is processed to discharge standards.

The Shanghai Jinshan Brewery also has a distillery waste solution anaerobic digester project. Using a new breed high-temperature anaerobic bacterium, the fermentation temperature is 64°C, with three-stage processing, a detention period of 4 days, and complete automation of production operations. The technological and economic norms of the design are: digester capacity of $2 \times 10000m^3$, aerogenic rate $\sim 7m^3/m^3 \cdot day$, methane production output $14 \times 10^3 m^3$/day ($420 \times 10^4 m^3$/year, with 300 operating days/year), raw material aerogenic rate $28m^3$/metric ton, daily processed distilling solution 500 metric tons, COD $4 \sim 5 \times 10^4$mg/liter (input) and $<$ 100mg/liter (output). After purification, each metric ton of distilling fermentation remnants can give 5kg of silkworm white feed. The methane produced provides for the daily use of 12,000 homes in Chengguan, Jinshan County.

The Nanyang Distillery has a $2 \times 2500m^3$ conventional methane pool using high temperature fermentation. In operation for 19 years, the aerogenic rate is $2.5m^3/m^3 \cdot day$. Now they have invested 9,800,000 RMB for a bigger $3 \times 5,000m^3$ digester, and a 20,000 home gas transmission network. The annual volume can reach $12,000,000m^3$, 18,000 metric tons of digester sludge (fertilizer), and enough methane for the use of 50 percent of the people of the city of Nanyang.

The Longquan Brewery in Liaoning is experimenting with a $30m^3$ process liquid distilling. Their processing apparatus is a nearly tubular fermenter with a two section filler mounted inside. The raw material COD is 20,000 $\sim$ 24,000mg/liter, the processing load is 19.0kg $COD/m^3 \cdot day$, COD removal rate is 85 percent, and the methane aerogenic rate is $9.5m^3/m^3 \cdot day$.

The Wuhan Municipal Energy Institute was the first in China to complete experimental research using an improved sludge anaerobic digester to process amylum waste water. High organic content, easy precipitation, and difficult digestion amylum waste water was successfully processed and the COD removal rate reached over 85 percent.

The Shenyang University of Agriculture set up the basis for distillation with sweet high millet stocks as raw material to make fuel. The stocks were compressed at a rate producing 60 percent liquid, put out a distillation rate of $7 \sim 8$ percent, and the distillation was infiltrated with a 15 percent ratio of gasoline.

II. Developmental Trends in Biomass Research

The raw materials of biomass energy are plentiful, their components complex, and their places of production dispersed. The quantity of calorific value and other useful components is low and the avenues of exploitation many.

In order to bring the application of biomass energy to a stage of industrial maturity where it has practical value for large-scale expansion, it will be necessary to tackle the problem with interdisciplinary cooperation from the various fields of biochemistry, microbiology, organic chemistry, chemical engineering and thermal engineering, chemical industry machinery and equipment, automation, environmental ecology, and systems engineering.

(1) Assessment of natural resources and rational use of biomass resources promotes total efficiency. The optimized structure of research in the use of biomass energy to compose a high-efficiency system from different environmental components, gradually realizing a finalization of models and standardization.

(2) The full utilization of agricultural resources to make methane gas into a major constituent of agriculture's fine circulation and the products developed there. In a study of small-scale, high-efficiency home use methane pools, with a pool size of $4m^3$, the aerogenic rate was $0.25 \sim 0.3m^3/m^3 \cdot day$.

(3) Research to develop large- and medium-type methane engineering techniques for towns and countryside to obtain optimal clean energy output and improve the benefit of the engineering investment. Study of organic waste production and comprehensive methane technologies in different industries. Research on technologies and methods to improve the environmental protection results of processing organic waste. Improve the efficacy of anaerobic digesters leading to the total degradation of organic matter, increase in the aerogenic rate, and improve the digestive solution to meet national disposal standards. The use in favorable dairy and pig farms of industrialized means to exploit methane utilization and develop gas collection and distribution.

(4) Develop gasification technology for plants study the conversion of solid biomass and organic city garbage into gaseous and liquid fuels.

REFERENCES

1. Lu Xianjiu [4151 0341 3773] Economic Evaluation of Industrial Methane Technology, Wuhan Municipal Energy Institute, 1986.

2. Tong Shusheng [0157 2885 5116], "Use of Fiber Filler in the Anaerobic Fermentation Process," NONGCUN NENGYUAN, Mar 86.

3. (Japanese) SOLAR ENERGY, Vol 40, No 2.

12966/9604
CSO: 4013/79

- END -

10

Foreign Broadcast Information Service (FBIS) and Joint Publications Research Service (JPRS) publications contain political, economic, military, and sociological news, commentary, and other information, as well as scientific and technical data and reports. All information has been obtained from foreign radio and television broadcasts, news agency transmissions, newspapers, books, and periodicals. Items generally are processed from the first or best available source; it should not be inferred that they have been disseminated only in the medium, in the language, or to the area indicated. Items from foreign language sources are translated. Those from English-language sources are transcribed, with the original phrasing and other characteristics retained.

Headlines, editorial reports, and material enclosed in brackets [ ] are supplied by FBIS/JPRS. Processing indicators such as [Text] or [Excerpts] in the first line of each item indicate how the information was processed from the original. Unfamiliar names which are rendered phonetically or transliterated by FBIS/JPRS are enclosed in parentheses. Words or names preceded by a question mark and enclosed in parentheses were not clear from the original source but have been supplied as appropriate to the context. Other unattributed parenthetical notes within the body of an item originate with the source. Times within items are as given by the source.

SUBSCRIPTION/PROCUREMENT INFORMATION

The FBIS DAILY REPORT contains current news and information and is published Monday through Friday in 8 volumes: China, East Europe, Soviet Union, East Asia, Near East & South Asia, Africa (Sub-Sahara), Latin America, and West Europe. Supplements to the DAILY REPORTs may also be available periodically and will be distributed to regular DAILY REPORT subscribers. JPRS publications generally contain less time-sensitive information and are published periodically. Current JPRS publications are listed in *Government Reports Announcements* issued semi-monthly by the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, Virginia 22161 and the *Monthly Catalog of U.S. Government Publications* issued by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

U.S. Government offices may obtain subscriptions to the DAILY REPORTs or JPRS publications (hardcovers or microfiche) at no charge through their sponsoring organizations. DOD consumers are required to submit requests through appropriate command validation channels to DIA, RTS-2C, Washington, D.C. 20301. (Telephone: (202) 373-3771, Autovon: 243-3771.) For additional information or assistance, call FBIS, (703) 527-2368, or write to P.O. Box 2604, Washington, D.C. 20013.

The public may subscribe to either hardcover or microfiche versions of the DAILY REPORTs and JPRS publications through NTIS at the above address or by calling (703) 487-4630. Subscription rates will be provided by NTIS upon request. Subscriptions are available outside the United States from NTIS or appointed foreign dealers. Back issues or single copies of the DAILY REPORTs and JPRS publications are not available. New subscribers should expect a 30-day delay in receipt of the first issue.

Both the DAILY REPORTs and the JPRS publications are on file for public reference at the Library of Congress and at many Federal Depository Libraries. Reference copies may also be seen at many public and university libraries throughout the United States.